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On Fluid Cavities in Meteorites.

By Heinrich Hensoldt.

(*Read August* 26, 1881.)

The paper which I have now the honour to read before this audience is the outcome of a discovery, furnished by accident, which I was fortunate enough to make about two years ago, and to which I attach some importance, having strong reasons for believing it to be original.

A series of observations and experiments, resulting from this discovery, have led to the accumulation of a number of facts which I consider to be of sufficient interest to justify the desire to make them more generally known.

The discovery consists in the detection of fluid cavities in a fragment of material which is undoubtedly of meteoric origin; at least, it was obtained under conditions which admit of no other explanation, as I will immediately proceed to show.

On the 19th of March, 1879, early in the morning, a shepherd, occupied with the erection of a pen in a field near Braunfels, a small town in the Rhine Province, Germany, was startled by a peculiar noise in the air above him, which he describes as a series of detonations, following each other in rapid succession; the whole being accompanied by a violent hissing. According to his narration, the whole phenomenon, which did not occupy more than about three seconds, bore a great resemblance to a clap of thunder, followed by a flash of lightning. There was, however, a clear, though not quite cloudless sky, and not the least indication of a thunderstorm observable.

Immediately afterwards, or at the same time, he noticed, in an adjoining field, fragments of earth and stone flying up as if the soil were being penetrated by some body displaying great force in its downward course.

The penetrating substance, which was found broken, or rather cracked, in several places, was subsequently discovered about 25 inches under the surface. It was an elongated, roundish mass, whose greatest diameter was about 11 inches; but a piece, which evidently had been severed from it by explosion before it reached the ground, and which must have been pretty large, was missing. In spite of very careful search in the neighbouring fields, this fragment was never found. The mass, which in the main presented the outlines of an irregular cone, had several branch-like protuberances on various parts of its surface; and showed every sign of having been in a state of fusion. Except where the missing portion was broken off, it exhibited no sharp ridges or edges; every part of its exterior being smooth and roundish. Though when dug out no longer warm, there were evidences pointing to the conclusion that it was in a highly heated condition when entering the ground. Portions of the somewhat sandy soil were found fused together, in close proximity to its position; and the surface of the object itself was covered with a thin crust, which, on after-examination, proved to possess no relationship with the component parts of the interior, and which evidently could have only been acquired by a highly heated substance coming in contact with fusible, sandy materials. The complete weight of all the fragments found was a little over 12lbs., and if we estimate the size of the missing piece by the proportions of the mass discovered, the weight of the complete meteorite may have been 20lbs. All the pieces found were obtained by my father, Mr. M. Hensoldt, of Wetzlar, who has still the greatest part of them in his possession.

Steps were then taken to ascertain, if possible, the nature of the components of this interesting visitor from another sphere, and not being sufficiently familiar with the tests furnished by analytical chemistry as to have direct resort to that means, but possessing some experience in determining the components of a mineral by microscopical investigation, we set to work by selecting one of the fragments, and cutting it into pieces in order to obtain a number of thin sections. In preparing these sections great difficulty was experienced owing to the extreme hardness of the material. Emery

was found scarcely efficient as a working substance, for it produced hardly any impression on the meteoric mass. By means of large and thin copper discs, rotating vertically on a lathe, and under the application of diamond powder, the fragment was reduced into sections of about one-eighth of an inch in thickness, and these, after having been polished carefully on one side, were fixed with balsam on a glass plate, and ground as thin as was compatible with their texture; and by the final polishing of the other side a degree of transparency was reached more than sufficient for microscopical examination.

Before, however, proceeding to describe the features which the sections exhibited under the microscope, I consider it of importance to mention the aspect which a polished surface of the material presented on examination with an ordinary pocket-lens. The polish, which, owing to the hardness of the material, is of considerable brilliancy, reveals two distinct substances, which appear to be the sole components of the meteorite. The one, of high metallic lustre, bearing a striking resemblance to polished steel or iron, is distributed in the shape of a minute network; the other, of a glassy character, filling the meshes of the network in so complete a manner that no vacuum of any sort is visible.

The shining substance of metallic lustre we at once considered to be metallic iron; a view which its great resemblance to that element, the weight of the material, and the frequent occurrence of metallic iron in meteorites, seemed to justify. This belief was further strengthened by the striking resemblance which a *broken* surface of the object bore to a broken surface of cast iron; the similarity being so great that it was difficult to point out any main features of deviation. But though we have held this opinion for nearly two years, I have quite recently, in consequence of more elaborate experiments, come to the conclusion that this substance is not iron in its pure or merely alloyed condition, but is a combination of that metal with a non-metallic element. This discovery seems, however, to lend only additional interest and importance to the matter, as I will attempt to show later on.

The observations made on the examination of a complete section under a low power of the microscope corresponded with, and confirmed those made previously with a pocket-lens. There appeared to be only two materials present; exhibiting, however, a striking contrast to each other—the one black, amorphous, and absolutely

opaque; the other colourless, crystalline, and transparent. The transparent material did not present itself in the form of definitely shaped crystals, but of a multitude of patches, exhibiting every variety of shape and irregularity. In point of relative quantity the two components seemed to be very evenly balanced, the transparent material occurring with the same frequency and bulk as the opaque, although in putting it precisely, I should feel inclined to say that the crystalline matter appeared to indicate a slight preponderance over the amorphous. The whole section, indeed, resembles a network of dark, opaque matter, in which the transparent masses are imbedded.

Although, as already stated, the transparent patches do not exhibit distinct crystallic outlines, it is by no means difficult to infer from their general appearance that they once possessed distinct crystallic forms; that they are, indeed, the fragments of crystals, which have, through the agency of violent forces, crushing, or sudden heating, been shattered and dislocated from their original positions.

But another feature is exhibited by these transparent masses, and one which is not so easily perceptible as the points to which I have already drawn attention. On examination with a 2in. objective, we already see scattered over the crystallic fragments, as I may call them, numerous fine points or dots, which in many instances occur in such considerable quantities as to form cloudy congregations, impairing to a slight degree the otherwise very perfect transparency of the crystalline matter.

It is to these fine dots that we shall now have to direct our chief attention, as the phenomena which they present, and the problems which they suggest, form the essence of this paper.

On mere superficial examination, those a little versed in microscopic petrology would consider these cloudy congregations of fine points to be microlites or crystallites; those minute bodies which are, as modern research has established beyond any doubt, the true elements of which the crystals are built up. They are present when crystallic forces are about to begin operation, and are likewise originated when crystals are undergoing a disintegrating process, as examples of numerous rock sections show us.

As we, however, increase the magnifying power of the microscope, these fine dots gradually enlarge, until each ultimately expands into a well-defined cell or cavity, which, according to its size, con-

tains, in almost every instance, a more or less large, roundish body in a state of continual motion. It is evident that these cavities contain a liquid of some sort, that they are, in fact, fluid enclosures, and that the moving bodies are bubbles of a gaseous nature, which are continually driven about by the variations in the temperature of the atmosphere, owing to their exquisite sensitiveness in consequence of their minuteness. The cavities are by no means of a uniform appearance, but exhibit every variety of size and form; nor does their grouping indicate the least order or regularity.

In the larger cavities I invariably found the bubbles to move slower, in some very slow indeed, and in the very largest the motion is scarcely perceptible; but if we examine the medium-sized and smaller cavities, we are startled to observe a very lively motion of the bubble in the interior. Indeed, I may safely say the rapidity of the motion of the bubbles is quite in proportion to the relative size of the cavities in which they occur.

Now the discovery of cavities in crystals, containing liquid matter, is by no means original, but is very old, as most of us will know. Rock-crystal, amethyst, and other minerals of the quartz type frequently contain liquid cavities, for the detection of which neither microscope nor pocket-lens is needed; cavities often so large that they have been known to contain several ounces of liquid matter. Even the discovery of *microscopic* liquid cavities containing *moving* gaseous bubbles has not been very recently effected, but is at least several years old. Very ingenious attempts have been made to establish the nature of these imprisoned liquids, and in many, if not in most cases facts have been ascertained from which very safe conclusions may be drawn, although the *presence* of most of the liquids in crystals has not yet been satisfactorily explained, owing to our still very imperfect knowledge of the laws which govern the formation of those extraordinary and mysterious bodies, the crystals.

But the discovery of liquid cavities in a *meteorite* is, as I have strong reasons to believe, original; at least, there is no instance on record of its having been previously made; and in the following I shall attempt to show the importance of this discovery, and the new light which it throws on meteorites, giving support to some theories, while antagonistic to others, respecting the origin of these remarkable objects.

Four years ago, Mr. Noel Hartley read a paper on fluid cavities

before the Chemical Society, which was subsequently printed in the Journal of that Society (March, 1877), in which he gave a most interesting account of his observations on this subject. After a series of elaborate experiments in order to establish the nature of the contents of cavities in topazes, sapphires, &c., he came to the conclusion (as others had already done before him) that in very many instances the imprisoned liquids consisted of the gas known as carbon-dioxyde, or carbonic acid, which, under certain conditions, can exist in a liquid state.

As a rule, the fluid occurring in the cavities of crystals had been found to be water, often containing high percentages of saline matter in solution. Sometimes, as Prof. Judd points out in his recently published work on Volcanoes, the saline matters are present in such quantities that they cannot all pass into solution, but crystallize out; and thus we frequently find cubic crystals of the chlorides of sodium and potassium floating in the liquids. In several cases the liquids have been found to be hydro-carbons, oily substances analogous to naphtha and petroleum.

From experiments I have made, similar, though not so exhaustive as those conducted by Mr. Hartley, I have ascertained that the liquid contained in the minute cavities of this meteorite is neither water nor a hydro-carbon, but that there can be hardly any doubt that it is liquefied carbonic acid. On warming the slide the gaseous bubbles disappear when a temperature of about 30° C. is reached, but return again on cooling, without any apparent diminution in size or moving capacity. Now, between 30° and 31° C. lies the so-called "critical point" of carbonic acid; that is, above this temperature carbonic acid cannot exist in its liquid condition, however great the pressure may be to which it is exposed. This is in accordance with an interesting law, the existence of which has been proved beyond any doubt by recent investigation. After certain temperatures are reached liquids enter into the gaseous state, no matter what the pressure may be. The temperature under which a certain liquid is no longer able to retain its characteristic features, but transforms itself into a gas, has been called by Prof. Andrews, of Belfast, its "critical point;" and from experiments made by him it has been convincingly shown that it is not possible to maintain the liquid condition of carbonic acid at any temperature beyond 30° 92′ C.

In all the cavities contained in the meteoric sections which have

come under my observation the bubbles suddenly vanished at a temperature of from 30° to 31° C., sometimes even exhibiting that peculiar phenomenon of ebullition to which Mr. Hartley, four years ago, has already drawn attention. Now, if the enclosed fluids had been water, the bubbles would not have shown the least indication of a change at this temperature. I heated a section of quartz, the cavities in which I knew to contain water, to the boiling point, without detecting the smallest effect on the bubbles.

Mr. Hartley, in numerous instances, found water and liquefied carbonic acid in the *same* cavity occurring in topazes, &c., the carbonic acid, from its lesser specific weight, floating on the surface of the water, and when he warmed the section the carbonic acid would become gaseous at 31° C., leaving only the water in its liquid condition ; but I have made no similar observation in this meteorite. I found only one liquid present, and this in every case appeared to be carbonic acid.

Among the many chemical tests which have been resorted to in order to determine the presence of carbonic acid in mineral cavities, I will only mention one, which has been quoted already by Mr. Hartley. Vogelsang and Geissler, of Bonn, crushed rock-crystal in which cavities occurred, which they suspected to contain liquefied carbonic acid, under baryta water, and observed that the latter became turbid owing to the formation of carbonate of baryta.

Now, taking for granted that the fluid material contained in the cavities of this meteorite which fell near Braunfels, is really liquefied carbonic acid, which we may safely do, as it presents no points of analogy to any other known substance; and that the bubbles, which move so restlessly about in their tiny prisons, are the same substance in its gaseous condition ; what do these facts teach us respecting the circumstances under which the meteoric mass was originally formed?

In recent years the belief has been gaining ground that meteorites are independent planetary bodies, miniature planets, so to speak, whose formation took place under conditions similar to those under which globes like this earth or Jupiter rose into being. From the fact that numerous planets very much smaller than the earth have been discovered, and that every improvement in the optical efficiency of telescopes adds to their number, and from the fact that streams of planetary bodies of minute size are known to move in regular orbits through the solar system, it is argued that

from the most gigantic planet to the minutest meteoric dust, we have to deal with the same class of existences; that the same processes led to the formation of all; that they are so interlinked by mere gradations regarding size and physical aspect that the term "meteorite" becomes vague, as we cannot draw the line where the planet ceases and the meteorite begins.

Now, such an assumption could be quite brought to harmonize with the hypothesis of Laplace respecting the origin of the heavenly bodies. The same laws which, in accordance with it, caused the formation of bodies, from the largest fixed star down to the smallest planet, might well lead to the origination of meteorites, if we only allow them a more elaborate scope of operation. Given favourable conditions, there is practically no limit in the grasp and grandeur of their achievements. "The solar system" (to quote Prof. Judd) "was formerly conceived of as a vast solitude through which a few gigantic bodies moved at awful distances from one another. Now, we know that the supposed empty void is traversed by countless myriads of bodies of the most varied dimensions, all moving in certain definite paths in obedience to the same laws, ever acting and reacting upon each other, and occasionally coming into collision."

Now, however plausible the independent formation of the so-called meteorites may appear, that is, however feasible it may be to identify their existence with the same process which led to the origination of the planets, and however well such a presumption may harmonize with the teachings of a widely recognised hypothesis, I believe I am justified in saying that the discovery of fluid enclosures in a meteorite must cause us to pause before we indulge in any further speculations from that starting point, as it is altogether antagonistic to it. The presence of these minute quantities of liquefied carbonic acid in a mass of meteoric origin is fatal to the presumption that meteorites are minute planets, formed under conditions similar to those which accompanied the development of those larger celestial bodies, which we have hitherto recognised as planets. These drops of carbonic acid, infinitesimal though they are, speak in a language which cannot be misunderstood, convincing us in the most conclusive fashion that at least the meteorite in which they occur has existed, or found existence, under circumstances which are incompatible with the assumption of its isolated development.

Carbonic acid is a gas which can become reduced to the condition of a liquid only under extreme pressure. Wherever we find enclosures of liquefied carbonic acid in terrestrial rocks, (and we find them frequently), we may take it for granted that the formation of those rocks has taken place deep in the earth's crust, under the gigantic weight of superincumbent masses. It has been found that cavities containing liquefied carbonic acid often occur in Basalts and other so-called basic lavas, which are known to be derived from deep-seated reservoirs beneath volcanoes, where, besides the weight of tremendous rock-masses above, we have the compressing force of great quantities of elastic vapour held in confinement; while in the so-called acid lavas, of which we possess very conclusive evidence that they are formed at no such very great depths, the presence of liquefied carbonic acid is extremely rare and exceptional. The fact that these liquid cavities are often contained in the crystals of granitic rocks is regarded by geologists as a most important evidence that the granites have been formed deep in the earth's crust, under conditions of enormous pressure; and we never find this liquid in sedimentary strata, or any other materials which are unlikely to have been exposed to extreme pressure during their formation.

It has been attempted to explain the presence of liquefied carbonic acid in the cavities of crystals, by the assumption of its origination through chemical processes, through changes which might have taken place in certain portions of the crystals, leading to the freeing and subsequent compression of the gas; but even the most ingenious argument which has been advanced, or *could* be advanced, to support such a theory, on closer examination hopelessly falls to the ground, leaving not the smallest room for doubt that all crystals occurring in terrestrial rock-masses, which contain enclosures of liquefied carbonic acid, must have been formed under conditions of enormous pressure, which we can only conceive to have taken place deep under the surface of our planet.

But how about extra-terrestrial rock-masses? How about meteorites in which we find liquefied carbonic acid in millions of minute cavities? Could they have been originated under circumstances totally different from those which prevail on this globe? Could the carbonic acid in them have been condensed to a liquid *without* extreme pressure? Certainly not; this would be little short of a miracle, and as we cannot conceive the possibility of

such a great pressure in a meteorite, we are brought to the conclusion that those bodies at one time of their history existed in the interior of mightier masses, planets, perhaps, of which they are the fragments.

It has, as we know, been ascertained, by means of the spectroscope, that the fixed stars are for the greatest part composed of the same elements as those which form this globe; and that most of the planets that are within our observation are composed of materials very similar to those which constitute the earth we have strong reasons for believing. Then we know that in the sun such a high temperature exists that all the non-metallic elements, and many of the metallic, are in the condition of vapour, and the rest of the metals in a state of fiery liquid; and that probably all the fixed stars are similar masses in different stages of cooling. We furthermore find traces of mighty igneous action on those planets which are nearest to our observation; for instance, the moon, which is covered in many parts of its surface with volcanoes on the grandest scale (now, as it seems, extinct for ever), and our own earth yet displays mighty volcanic forces, which seem to have been grander still in the past.

Although, as Prof. Judd has shown in his recent publication, the presence of volcanic elements on our globe may be very well explained without assuming that the interior of the earth is a molten mass, yet there appears to be very little room for doubt that the earth was once in the same condition as the sun now, and that all the subsequent changes have been effected through cooling, and we may safely infer that the history of all the planets presents the same features.

What, therefore, can there be improbable in the supposition that among the myriads of those fiery drops, or half-cooled orbs, but in whose interiors mighty volcanic elements still are busy, one should *explode* now and then, and people the universe with its fragments? We have evidence to prove that in past periods of the earth's history the explosive force of vapours held in confinement in the interior of our planet has been great enough to blow away mountains ten miles in diameter, leaving chasms which are now in many instances filled by lakes;* and what eruptive power has been able to achieve on this globe as recently as 1772 is shown by an occurrence in the island of Java, where a volcano, 9,000 feet

* Judd, "Volcanoes," pp. 170 to 174.

high, called Papandayang, suddenly burst into eruption, and in a single night threw thirty thousand million cubic feet of materials into the atmosphere, which fell upon the country around, burying no less than forty villages. After the eruption, the volcano was found to have been reduced in height from 9,000 to 5,000 feet, and to present a vast crater in its midst, which had been formed by the ejection of the enormous mass of materials.

That heavenly bodies, such as fixed stars or planets, should be capable of exploding, seems not only possible, but extremely probable. If in the interior of our own planet the force of vapours held in confinement has been great enough to transplant gigantic mountains, and to effect the most appalling changes in the aspect of the surface, there is nothing illogical in the conclusion that vast accumulations of gases may lead to the shattering of whole worlds, or that the violence of explosion may ruin them partly, hurling fragments far enough to place them beyond the attraction of the remaining wrecks.

On such stupendous explosions taking place, it is almost certain that great numbers of fragments would be sent through space in similar directions, forming swarms, which, on coming within the attraction of some great body, would take definite courses, while many others would be so directed as to diverge, the further they move, till each pursues a solitary path. The magnificent showers of so-called "shooting stars" have been proved to be caused by the passage of the earth through such bands of travelling bodies; and even comets have now been identified with streams of planetary bodies of minute size, moving in regular orbits through our system.

Now, as it is extremely probable that meteorites are fragments of celestial bodies, vastly mightier than themselves, their closer examination leads us to the conclusion that at least those which have from time to time fallen upon the earth's surface are derived from planets very similar to, if not identical in their composition with our globe.

The existing literature on meteorites is very poor; fifty years ago there were hardly two works to be found exclusively devoted to meteorites, and at the present moment we are only in the possession of very few and isolated attempts to treat the subject with the amount of attention which its importance deserves.

There has not as yet been discovered in a meteorite one single element which does not also occur on the earth, and the mineral

combinations under which these elements present themselves are, with but few exceptions, those with which we are familiar among terrestrial rocks. Chief among the materials which are the most frequent components of meteorites is iron in its pure metallic state. Indeed, by far the greatest number of the meteorites in our museums and private collections are masses of iron, and in the majority of the remainder metallic iron is present in greater or less quantity.

It was therefore customary at first to divide meteorites into two sections—into the meteoric stones and the meteoric iron—until recently, after more elaborate investigation, a more complicated classification has been resorted to, and M. Daubrée, divides the meteorites into Holosiderites, or such as consist almost entirely of metallic iron; Syssiderites, in which a network of metallic iron encloses a number of granular masses of stony materials; Sporadosiderites, consisting of stony materials through which particles of metallic iron are dispersed; and fourthly, Asiderites, or such as contain no metallic iron, but consist entirely of stony material.

Now, besides the presence of liquefied carbonic acid, which I may safely say has been established in the meteorite of Braunfels, there is a series of other evidences which the limit of this paper does not permit me to dwell upon as fully as I should wish, bearing strong proofs that this and perhaps most meteorites are not only derived from mightier masses, but that they come from the *interiors* of those masses, and are the resultants of explosions.

If we examine those minerals which most frequently occur in meteorites, we are startled to observe that they are, almost without exception, those which constitute the basic lavas, those volcanic productions which, as I have already pointed out, are derived from the deepest-seated igneous reservoirs in the crust of our planet.

Olivine, Enstatite, Augite, Anorthite, Magnetite, and Chromite, are most frequently contained in meteorites, and they are the minerals of which the so-called basic and ultra-basic lavas almost exclusively consist. Masses bearing the most striking resemblance to meteorites, and being composed of substances identical with those which constitute the latter, are sometimes ejected from volcanic vents in the shape of so-called volcanic bombs, and even metallic iron, which never was believed to occur in terrestrial rocks, has now been discovered in basaltic stones, alloyed even with those two other metals, Nickel and Cobalt, which form so characteristic a feature in the iron of meteoric origin.

We know comparatively little of the interior of our planet, being only acquainted with a very insignificant portion of its crust; and even the basic lavas, which in all probability represent the deepest known regions of that crust, furnish us with but very scanty information respecting the nature of the vastnesses beneath.

But though we shall probably never be able to ascertain the condition of the interior of the earth by direct observation, we are in the position to say that the masses forming this interior are different from those which constitute the crust. It has been established that the average density of the materials which compose the globe is $5\frac{1}{2}$ times greater than that of water, but that the density of the materials composing its *crust* is not quite three times that of water. We are thus driven to the conclusion that the interior portions of the globe are composed of materials having twice the density of the rocks which we find at the surface.

Now it seems to me that in the meteorites which from time to time have fallen upon the earth's *surface*, we have been provided with a most important collection of objects on which to study the condition of its *interior*. Being the fragments of other planets, they confirm in a remarkable manner those general conclusions which we have been enabled to draw from undisputed facts regarding the interior of the globe. The density of by far the largest number of them wonderfully coincides with that of the greater portion of the globe. It has been often pointed out that the interior of the earth is in all probability one vast metallic mass, either liquid or solid, consisting for the greatest part of iron; and among the meteorites we have a great preponderance of iron masses, while the different classes of meteoric *stones* represent a variety of lesser depths, those which are of an essentially stony character being derived from portions of the crust.

Now, from these general remarks on meteorites, and what they teach us respecting the interior of our planet, and the condition of a great portion of the universe at large, I must, before concluding this paper, return once more to the meteorite of Braunfels, which remains the subject of our closer attention.

I have described how a thin section shows this meteorite to be composed of two materials, one crystalline and transparent, and the other amorphous and opaque. The transparent material I have found to be a silicate of the Phenacite group, and closely resembling Phenacite in all its characteristics; and the amorphous substance, which so strikingly resembles iron in its pure metallic

state, I have found to be iron, combined with about 15 per cent. of Oxygen, presenting a peculiar mineral somewhat analogous to the sesquioxyde of iron, yet possessing most of the properties of pure iron. I am inclined to attach considerable importance to this latter circumstance, as a similar combination has not before been observed in any known meteorite; and if time only permitted me, I would try to show its particular value in the study of these remarkable objects.

I would class the meteorite of Braunfels among the Syssiderites of M. Daubrée, that section of meteorites in which a network of iron encloses a number of granular masses of stony materials; for although the substance which constitutes the network in this instance is not pure metallic iron, its deviation from that metal is not sufficiently apparent to warrant the drawing up of a new class of meteorites, unless we consider them entirely from the basis of their chemical components.

Respecting the fluid cavities, it may be urged that, considering that I have not as yet been able to attest the nature of their contents by direct analysis, I am not justified in taking for granted that the liquid which has come under my observation is carbonic acid. To this I would reply that if my experiments do not enable me to absolutely prove the presence of liquefied carbonic acid in the cavities of this meteorite, their results at least permit me to say that if the liquid should, contrary to all expectation, *not* be carbonic acid, it must be an extremely volatile substance so closely resembling carbonic acid in all its peculiarities, that those general conclusions which I have drawn from its presence respecting the origin of the meteorite, &c., would not in the least be impaired.

In concluding this paper, I must, in a certain sense, apologise for bringing a subject which seems to involve so much of mineralogy and physics before a Society so exclusively devoted to microscopy as the Quekett Microscopical Club. I might have easily confined myself to the mere aspect, under the microscope, of the sections of the meteorite of Braunfels, and to my observations on their fluid enclosures; but I could not resist the temptation of drawing at the same time attention to what in my humble opinion seem important issues; and if I should have erred here and there, or have been too sanguine in my expressions, I trust that others better qualified than myself will investigate the subject and arrive at truer conclusions.

On the Injection of Specimens for Microscopical Examination.

By T. Charters White, M.R.C.S., &c., *President.*

(*Read September 23rd,* 1881.)

Dr. Carpenter, in treating of the injecting of the vessels of an animal in order to show their arrangement in the various organs of the body, says, "The art of making successful preparations of this kind is one in which perfection can usually be attained only by long practice, and by attention to a great number of minute particulars; and better specimens may be obtained therefore from those who have made it a business to produce them, than are likely to be prepared by amateurs for themselves." Now, while I have every respect for the utterances generally of this distinguished microscopist, I must take exception to this statement. I can agree with him so far as he commends the beauty of the injections made by our friends A. C. Cole and Topping, and of others who devote themselves to this particular branch of microscopical preparation, but beg distinctly to differ from him in the statement that their labours are perfection, however admirable and beautiful they may be as examples of successful work. Given an amateur, who, by a little practice, can carry out this branch of work with tolerable facility, and who does not disregard in an organ the relationship of the other anatomical elements to its vascular arrangements, then, I say, he will produce much more instructive work than any exclusively professional mounter. We are accustomed to see extremely beautiful and perfect injections exhibited by these gentlemen, but none showing anything beyond the injected vessels; all the substructure which bears an intimate relation to the vascular arrangement is entirely obliterated. This to a certain extent may be due to the mounting medium employed in putting them up, but does not alter the accusation I bring against them; and if a mounting medium could be devised and employed which would show the adjacent structures at the same time as the vessels, then, I say, the professional mounters would have reached the pinnacle of perfection. Having no regular paper set down for reading this evening, I have come forward at short notice to stop the gap by one of those casual communications I have often under

similar circumstances offered to the Club, in the hope of making it appear to the members not such a difficult task for any amongst us to take up the subject of injection. Of course in injecting such animals as Fish or Mollusca, more difficulty will at first be experienced than with a small Mammal; but when once the student attains tolerable facility in the use of the apparatus I will presently describe, no great difficulty will present itself in injecting any member of the Animal Kingdom.

I have placed under my microscope this evening an injected preparation from the small intestine of the Guinea pig, not as an example of perfect injection, but to show more clearly what I mean by having a regard to the other elements of a structure besides the vessels; and I will describe the *modus operandi* by which I produced that preparation, and advise such of you who may wish to follow up this branch of work to undertake it with the full assurance that what I have but imperfectly performed would, with more time and attention than I could give, be attended by far more beautiful and instructive results. I do not wish to say anything relative to *opaque* injections, because I have had no personal experience in their production, but I shall confine myself to the making of transparent injections with cold injection fluid, although I believe that very beautiful preparations could be made by the amateur with a little attention to temperature, by using a warm injection of gelatine stained with carmine. With regard to the instrument to be employed, I may say that although a syringe is generally recommended to force in the injection, I found it attended by so much unsteadiness and fatigue, followed often by bursting of a vessel and consequent extravasation, that, however deftly it may be employed by the professional injector, I gave it up, and resorted to gentle and continuous pressure by a falling column of the fluid injection. The injection I used was Beale's Blue fluid, and as this requires a little care in its preparation, directions for its proper combination may be fitly inserted at this stage of the description. The formula I have found most satisfactory is that given by Dr. Beale in "How to Work with the Microscope," at page 114, and is as follows :—

Glycerine, 2 ounces.
Wood Naphtha, 1½ drachms.
Spirits of Wine, 1 ounce.
Ferrocyanide of Potassium, 12 grains.
Tincture of Sesquichloride of Iron, 1 drachm.
Water, 3 ounces.

The ferrocyanide is to be dissolved in one ounce of the glycerine, and see that every particle is dissolved before proceeding to mix. The tincture of iron may be added to another ounce of the glycerine, and well stirred in ; now add these two solutions gradually to each other, well shaking them in a bottle after each addition.

The iron must be added to the solution of ferrocyanide; this is strictly imperative. When thoroughly incorporated this mixture should produce a dark blue fluid without any flocculi, and with no sediment; the naphtha may then be mixed with the spirit of wine and the water, and gradually mixed with the blue fluid.

Having now made your injection, it may be placed in a wide-mouth glass jar on a shelf, about five feet above your table; cut two holes in the cork, which should fit the bottle accurately; in one hole place a small funnel, so that air may get to the interior of the bottle, and should the injection threaten to become exhausted before the completion of the process, some more can be poured in; in the other hole insert a bent glass tube, one end of which should reach in the inside of the bottle to the bottom ; the other end may be left four inches long, and turned over in a good arch; on this end fit about six feet of india-rubber tubing of a size to tightly embrace the glass tube; in the distal extremity of this tubing fasten a small stop-cock. If now suction be made at this, the injection will flow out of the bottle down the tube; the stop-cock can be turned, and thus the tube will be charged without containing any air. Having now your injection so far ready, prepare some nozzles of a suitable size to the vessel you intend to put the injection in. The best can be made from a piece of the glass tubing of the same calibre as that inserted in the bottle; draw some pieces of about two inches in length to capillary points in a flame, and then break off the tips to correspond with the diameter of the blood-vessel you select to operate on; twist some fine wire round the wide end of each of these canulæ, and fix them with some sealing-wax; slip over the end of that you intend to employ a short length of the same tubing that you have attached to one end of your stop-cock. Now, having all these appliances at hand, select the subject to be injected. This may be either a young kitten, or a rat, or such-like small mammal; it must be procured alive, and may be drowned or chloroformed to death ; and *directly* after death, the sooner the better, the thoracic region may be well laid open by cutting with a stout pair of scissors through

the ribs on each side of the chest; never mind the intercostal vessels, they will not let out much injection, at any rate nothing to signify.

Now, although life may be perfectly extinct, the muscular contractility of the heart will exert itself, and the pulsation of that is an indication of the elasticity of the vessels; when once that has ceased the injection will not flow so freely, as an impending *rigor mortis* will have taken possession of the coats of the vessels, and will be a serious hindrance to the access of the fluid into the capillaries; lay open the pericardium, the bag which envelopes the heart, and you will see the aorta springing from the left ventricle, and arching over by the left side of the spine, descending to the abdomen; cut off the apex of the heart, and insert the nozzle you have prepared, first taking the precaution to fill it and the attached tube with water; push it gently upward through the cavity of the heart till you see it enter the aorta, when with a curved needle you may pass a ligature under aorta and pipe, and tie them, securely fastening the ends of your ligature to the wire studs twisted on your glass tube; that will prevent it slipping out again; see that it is filled with fluid to the top, so that all air may be excluded, and then make your connection with the stop-cock, first letting a few drops of the injection flow through it; when your tube is continuous turn on the stop-cock, and you will soon see the various organs become tinged with blue, the larger vessels first, and coursing along these, it will branch off into innumerable fine channels, till the whole capillary system is full; and the excess coming out of the right side of the heart will tell you your work is complete.

Your subject may remain to be cut up at your leisure, for the glycerine in the injection will act as a preservative for some considerable time. This, then, was the process adopted for the injected preparation under my microscope this evening. You will see that the blue fluid has run into the finest capillaries. But it is said we learn more from our failures than from our successes; and therefore, as that preparation is far from what you can admire from an æsthetic point of view, it will prove all the more instructive if I point out an error I fell into. You will see that in a great many places the blue injection has entirely faded out, and in others that it is very pale. I believe this has arisen from the blue fluid not being sufficiently acid to neutralise the alkalinity of the blood remaining in the vessels; and this seems substantiated by those specimens where the preparation has been put into ammoniacal

solution of carmine, which has entirely obliterated the blue, only sufficient traces of it being left to tell of its departed beauty. The next time I do this I shall put a little acid into my blue injection. I once derived much good from having two wide-mouthed jars, one containing a weak warm solution of salt and water, which I allowed to flow through the capillary system in a similar manner to that I have described as employed for the blue fluid prior to sending in the injection, while my subject was manipulated under warm water; this excluded every possibility of air getting into the circulation, which is always to be avoided as most ruinous in its results. These perhaps wearisome details comprise the whole of the process I have always employed; of course, others have tried the same process, but I thought that it would be better to tell you how I acted, as if no one else did the same thing, because I could make my short paper more didactic; and you will see by my poor specimen that with greater care this process is capable of producing some very beautiful and instructive results. You will, in the subsequent examination of it, be able to determine how much is the result of the mounting medium in which I have placed it; for my part, I believe it is entirely due to this that not only the villi but the Lieberkühnian follicles are most clearly shown with the capillary vessels coursing all through and around them; and I must aver that had this specimen been mounted in balsam or dammar, every detail would have been sacrificed. I consider balsam to be the greatest bane Histology has to fight against. The specimen I show to-night, after being saturated with the glycerine from the injecting fluid, only required a little weak glycerine and camphor water to put it up in; and you will see the consequence is a preservation of everything that would be otherwise blotted out. I must apologise for very much in this very imperfect paper. It is almost too short to deal exhaustively with the subject of injecting; much must of necessity be left unsaid that might with advantage be spoken, but if any member desires to take up this subject and work at it, I can only recommend him to read up Beale's "How to work with the Microscope," and Frey's "Microscope and Microscopical Technology," which works deal very fully with the various injecting fluids that may be employed; then if glycerine or glycerine jelly be employed as mounting media, preparations will be exhibited which will prove Dr. Carpenter's dictum applicable only to the past.

On the Structure and Division of the Vegetable Cell.

By W. H. Gilburt, F.R.M.S.

(*Read Nov.* 25, 1881.)

Plate I.

Schleiden, who was the founder of what is known as the "Cell theory," defines the vegetable cell as "the elementary organ which constitutes the sole essential form-element of all plants, and without which a plant cannot exist," and as consisting, when fully developed, of "a wall composed of cellulose, lined with a semi-fluid nitrogenous coating." With him, therefore, a cell consisted of two elements only, a closed vesicle, with a wall more or less firm, and its semi-fluid parietal lining. In the year 1833, however, a third element was added by Robert Brown, who first observed and described the nucleus in certain Orchids; and Schleiden subsequently pointed out its regular occurrence in at least the young cells of all flowering plants. He also discovered in it a denser body, which may, however, be sometimes absent, the Nucleolus.

Here then we have the idea of a cell as a threefold structure, the cellulose wall, the semi-fluid contents, and the nucleus, to the second of which Von Mohl gave the name of protoplasm.

This conception of the nature of the vegetable cell is the one which is still most commonly held, and each of its component parts is generally regarded by those who have only a general knowledge of the subject as of equal value.

A little consideration will, however, show that such a view does not fully represent the facts of the case, for if we regard the cellulose wall as an essential part of a cell, we exclude some of the most important protoplasmic structures which are developed during the life of a plant. For instance, the contents of the young embryo-sac of a flowering plant consists of a mass of protoplasm with a nucleus. During the period of the growth of the ovule this nucleus divides, giving rise to two daughter nuclei; in these secondary nuclei division again takes place. Thus we have four, all embedded in the general protoplasm of the embryo-sac, two being placed at each pole. Division again takes place in the

nuclei, thus forming a group of four at either end. Up till this time the protoplasm has remained entire; but now one nucleus at either end draws itself away from the remaining three, when, between each of the latter, a division of the protoplasm takes place, and the protoplasm surrounding each nucleus contracts, and assumes an individuality which it did not before possess. One of these little masses at the upper end is the egg-cell, the other two the Synergidœ, while the three at the lower end form the antipodal cells. Now each and all of these are, and remain till fertilization, naked, nucleated protoplasmic masses, and one at least of them the most important cell that the plant can produce. Another example may be mentioned in which not only is a cell, but many, without walls, and forming a developed tissue, viz., the tissue in the sporangium of *Equisetum*, from which the spore-mother cells are produced. The same holds good of the spore-mother cells themselves, and it is not till after the final division has taken place that any cellulose is deposited on their surface. In fact, were the definition of the triple structure rigidly applied, not only would a few but most of the egg-cells of all plants be excluded, and also many of the spores of both the higher and the lower Algæ.

In the year 1845 the comparative unimportance of the cell-wall was pointed out by Nägeli, and this conclusion was soon adopted and emphasized by others, especially by Max Schultze, who observing, as has just been shown, that many of the most important cells were destitute of a membrane, defined a cell as "a little mass of protoplasm, inside of which lies a nucleus." This definition did not, however, include all the vegetable protoplasmic structures either with or without a cell-wall, for many had been observed in which no nucleus could be seen. Examples of such are to be found in the Antherozoids of the Cryptogamia, and at that time most, if not all the Fungi, were regarded as being without a nucleus, in addition to many other Thallophytes. For such elementary structures Häckel, in 1866, proposed the name of Cytode. We have, then, this distinction: A cell is a "little mass of protoplasm, inside which lies a nucleus;" while a cytode is "a little mass of protoplasm without a nucleus." This appears to rather complicate matters, as instead of having only one morphological element, we have, so far as terminology at least is concerned, two, the cell and the cytode. The latter term may, however, eventually have to be abandoned, at least with

regard to the vegetable kingdom; for Professor Schmitz has been enabled to demonstrate the presence of nuclei in many Thallophytes hitherto considered to be destitute of them, and even in plants of so low a type as the Yeast plant; and he concludes "that in all Thallophytes the cells invariably contain one or more nuclei, organisms destitute of a nucleus being altogether unknown."* If, therefore, these observations and conclusions should be confirmed, as in all probability they will, we shall be brought back to the one element of plant structure and life, the cell, as a nucleated mass of protoplasm which may or may not be bounded by a cell-wall.

Having thus given an extremely brief and, of necessity, very incomplete sketch of the history of the Cell theory, we may now turn to a consideration of its intimate structure as at present known.

Taking the first, that very generally present, though non-essential, element of cell-structure, the cellulose wall; although there may be nothing either new or very recent to bring before you, yet a brief review of the known facts and present theories concerning it may not be altogether out of place. You will of course know that cellulose is, chemically, a compound isomeric with starch, sugar, and inulin, its formula being $C_6 H_{10} O_5$. Under the microscope it presents itself normally in young cells as an extremely thin, transparent, homogeneous pellicle. As it becomes older, it increases in thickness, but frequently even in what are commonly spoken of as thin-walled cells, the thickening takes place unequally; and isolated, or groups of spots remain as thin, or nearly so, as when the wall was first formed, while in still older cells these thin places are sometimes dissolved, and a clear aperture remains between the two adjoining cells.

Under the highest powers of the microscope nothing which in any true sense can be called structure is to be seen, yet, in common with all matter, we must look upon it as being molecular in composition, the molecules being solid, isolated particles, between which water penetrates. Now in order to readily understand how, according to present views of growth, the cell-wall increases in superficial area, it is desirable that a clear mental picture should be formed of this molecular structure. True, we cannot give even a rough guess at the extreme minuteness of these component

* "Journal Royal Microscopical Society," 1880, p. 438.

molecules, and therefore cannot possibly estimate how many layers would be required to make up the thickness of even the thinnest cell-wall. Still this is by no means necessary. In order therefore, to render the idea as simple as possible, let us imagine a wall composed of say three layers, and the molecules, if you will, as large as peas. Now imagine that these peas are floating in a viscid fluid medium somewhat denser than themselves, but each pea kept apart from, and in its relative position with regard to its neighbours, by reason of an attractive force which is inherent in itself; so that when uninfluenced by external conditions, this structure and all its individual parts are relatively in a state of stable equilibrium. Now in imagination reduce the size of the molecules as much as you like, but, preserving the general idea of this extremely rough illustration, you have a conception of the present view as to the structure of the cell-wall. That such a theory represents the facts of the case is highly probable, seeing that it, far better than any other which has yet been suggested, enables us to account for the increase of the area of the cell-wall during the process of growth. It should be always borne in mind that nothing like life can be ascribed to the cell-wall, that the substance of which it is composed has no power of increasing its own bulk, and that any extension which takes place in it is due solely to the protoplasm which it encloses. Growth of the cell-wall takes place by intussusception, *i.e.*, the intercalation or insertion of new molecules between those already existing. Remembering that between the existing molecules we have a layer of water which envelops them on every side, it will be seen that if by any means, we can obtain a force or pressure internally which shall, so to speak, stretch the existing cell-wall, and therefore separate the component molecules farther from each other, there is nothing to hinder the insertion of new molecules amongst them. And such a force exists, and results from the eagerness with which young and growing cells imbibe water, thereby producing a condition of great turgidity, and keeping the thin cell-wall in a state of tension.

The question naturally arises as to how these new molecules which are required to build up the cell-wall are produced. Are the elements of the cellulose held in solution in the water of organization, as it is called, which occupies the interspaces between the existing molecules, waiting, as it were, for room to combine?

or are the molecules themselves prepared on the surface of the protoplasm and afterwards inserted? In all probability the former is the case, as otherwise the difficulty, which is now very great, in accounting for some facts, would be greatly increased; for instance, the beautiful sculpturing which we find on the external surface of many pollen grains is produced by forces acting from within, and is due to growth by intussusception; and while we cannot understand how it is that these patterns should be always present and so constant in design by any theory of growth, yet to suppose that the molecules are prepared on the surface of the protoplasm and then forced through would certainly not help, but rather otherwise. It should not be supposed, however, that the presence of cellulose is necessary to its further production in cells which are invariably clothed with it. Strasburger has shown that the protoplasm of the sac of *Vaucheria* may be made to contract and draw itself away from the wall, when it will immediately commence to produce a new one, free from the original; and this experiment he repeated successfully with the same part of the same sac. Another and perhaps better example of the production of cellulose by the protoplasm apart from any already existing is seen in the formation of the new wall in a dividing cell, the whole division plate being laid down at once before any separation can be perceived in the protoplasm. We may therefore say, that while chemical affinity of some kind plays a part in the production of these molecules, it is and must be the result of physiological action.

We come now to a consideration of the more important constituents of the cell, those parts in which life inheres, and upon the presence and activity of which all growth and increase depends—the protoplasm and the nucleus. We are all, doubtless, more or less familiar with the appearance presented by a growing cell under the microscope—say in a section not far removed from the apex of a stem, or in a fragment of a very young leaf. The thin cell-wall is apparent, and we find it either wholly or in part occupied with a transparent semi-fluid substance, in which are imbedded a large number of minute granules, which appear dark or bright according as we look at them in focus or otherwise. In the midst of this substance we observe a globose or ovoid body more highly refractive and much denser than the general contents of the cell.

Protoplasm is sometimes spoken of as a fluid, but under no conditions can such a term be strictly applied to it. A fluid always

takes the form of the vessel in which it is contained, but a living protoplasmic mass will never do this. An Amœba in water, even those forms which appear to have the largest proportion of the medium in which they live entering into their composition, does not *flow* over the surface of the slip upon which you place it; it protrudes a part of its substance, but it also retracts it; it would just as soon travel up an inclined plane or vertical surface as on a horizontal one. Its substance is clearly under its own control, using the term in its most limited sense. The protoplasm of the vegetable cell is essentially similar in this respect to an Amœba. There is the same general appearance in the one as in the other.

The outer portion of an Amœba is, as you know, clear and hyaline, all granules are absent; and, moreover, it is evidently denser than the inner portion. And this description holds as well for our plant cell as for the Amœba, only that in the former the clear outer portion is far thinner, and therefore less easily seen than in the latter. Still it is there, and can be without difficulty demonstrated by application of a dilute acid or alcohol, which by causing the cell contents to shrink, at once brings it into view. It was the clear hyaline layer which the earlier observers took for a skin, and to which they gave the name of Primordial utricle; but it has now long been known that it is nothing more than a denser portion of the general protoplasm; there is no line dividing it from the softer parts, the density simply increasing gradually from without, inwards. In order to distinguish one from the other, the names of Ectoplasm and Endoplasm have been used, but it should be clearly understood that it is impossible to tell where the one leaves off and the other commences.

Sachs says, "At the base of all protoplasmic structure there probably lies a substance which is colourless, homogeneous, and not visibly granular; to it alone the name of Protoplasm ought perhaps to be applied, or at all events it ought to be distinguished as the foundation of protoplasm." "The fine granules which are so often mingled with it are probably finely divided assimilated food materials, which undergo a further chemical metamorphosis into protoplasm."

Now the question of the homogeniety or otherwise of living protoplasm is one which has been claiming and receiving great attention at the hands of some of our best biologists during the last few years. Dr. Beale, for whom we must all hold great respect, has, as

we know, stated most emphatically that all living matter is structureless. He says, to quote one of his most recent utterances, "Living matter has no definite structure whatever; in fact, its particles, and very probably their constituent atoms, are in a state of very active movement, which renders structure and fixity of arrangement impossible, this active movement being an essential condition of the living state, which latter ceases when the movement comes to a standstill. According to this view, the idea of structure as belonging to living matter is inconceivable." Now, given the molecular structure of protoplasm, which Dr. Beale appears to agree with, the active movement would also be included. According to the present doctrine of the constitution of matter, its primary element is an atom. That the atoms of the various elementary substances combining in certain definite proportions form molecules, which possess certain definite qualities; that the molecules as such, and the atoms composing them, are alike in active motion; that the chief difference between the three states of matter, solid, liquid, and gaseous, consists in the amount of movement of which the molecules are capable; and it would appear that only in the two latter are the conditions such that movements of sufficient freedom or amplitude could take place so as to preclude the possibility of structure.

It has been shown already that protoplasm is not a fluid, and that its density is dependent upon the quantity of water present, the proportion of which varies within wide limits, from a condition in which it appears to preponderate to one in which it is nearly absent, and the protoplasm stiff and even brittle, as, for example, in the embryo of some seeds. Here we have a condition in which the protoplasm is practically a solid, and yet it is not only alive, but is capable of preserving its dormant vitality, often for a long period, and only requires suitable conditions as to heat and moisture, for physiological action to be resumed and growth to take place.

From this it would appear that while water is undoubtedly necessary for the purposes of nutrition and the other operations for continued life and development, we may fairly assume that at least it is not necessary for the *existence* of protoplasm that water should be present in such excess as we sometimes see it; and seeing that even in vegetable cells, where growth and development are most active, the protoplasm certainly is not a fluid either in appearance

or consistence, we may conclude that in instances such as some of the Amœbæ, where they appear little denser than the medium in which they live, we have not protoplasm only, but protoplasm plus water ; and such being the case, there would seem to be no reason for concluding, from its physical constitution, that the idea of its possessing structure is inconceivable.

When, however, we pass from such considerations as these and look at the infinite variety of life forms, both animal and vegetable, with all their varied functions and capacities, and remember that they each and all had their origin in a microscopic mass of this protoplasm ; the thought that for them all this substance from which they arise is absolutely alike is to say the least difficult of belief. Dr. Allman, in his presidential address before the British Association in 1879, deals with this question in a most forcible manner when he says, "To suppose, however, that all protoplasm is identical where no difference is cognisable by any means at our disposal would be an error. Of two particles of protoplasm, between which we may defy all the powers of the microscope, all the resources of the laboratory, to detect a difference, one can develop only into a jelly fish, the other only to a man, and one conclusion alone is here possible : that deep within them must be a fundamental difference, which thus determines their inevitable destiny, but of which we know nothing, and can assert nothing, beyond the statement that it must depend on their hidden molecular constitution." "In the molecular condition of protoplasm there is probably as much complexity as in the disposition of organs of the most highly differentiated organisms ; and between the two masses of protoplasm indistinguishable from one another, there may be as much molecular difference as there is between the form and arrangement of organs in the most widely sepraated animals or plants." Certainly this view of the question could not possibly be presented in a better form, but it may perhaps help us to realize how extremely probable this is if we remember into what diversified products the same elementary substances combining in the same proportions give rise. We have already seen that cellulose, sugar, starch, and inulin, are isomeric with each other, that is, that the elements and combining proportions are the same in each case, although they possess such very different physical characteristics. A far more remarkable example is, that in twenty-seven volatile oils, including those of chamomile, hops, turpentine, clove, lemon, valerian ; the carbon

and hydrogen are united in the same proportion, viz., ten to sixteen atoms."* Now if in nature's laboratory, from the same materials in exactly the same proportions, substances so different, and cause ing in us such varied sensations, are produced, by simply altering the arrangement of the constituent atoms, can we doubt the possibility that an almost endless diversity may exist in the arrangement of the elementary atoms of which protoplasm is built up?

But it would seem that there are other reasons why we should look for structure in protoplasm, not only molecular, but of a coarser sort. One of the chief characteristics of all protoplasm is its contractility; not merely a shrinkage or apparent decrease in size, which sometimes occurs through loss of water, but that kind of contractility which results in motion—motion which may be regular like that of the muscles, or irregular like that of the Amœbæ. That this property exists in vegetable protoplasm as well as in animal is well known. Examples of it are met with in the phenomenon of cyclosis as seen in many hairs, in *Vallisneria*, &c., but many which approach nearer in appearance to what we call Amœboid are not difficult to find. For instance, if the sac of *Vaucheria* be ruptured, and the protoplasm allowed to escape into water, amœboid movement is set up in it, and may continue for some time. In the plasmodium of the Myxomycetes the same phenomena are also shown in a remarkable manner, and in the cells of the higher plants, when the protoplasm forms a somewhat thick and dense parietal layer upon the wall, a wave may sometimes be seen to travel along it, not a transposition of the protoplasm, but simply a contraction and expansion which passes from one end of the cell to the other. Now, as we watch these movements, we find that it requires an effort of the mind to resist the impression that behind them all there is volition of some kind, and also that there must be some machinery by which these movements are effected. As to the idea of *will*, that cannot for one moment be retained; but the presence or otherwise of structural elements, by the employment of which these contractions are brought about, is a question which may well be at least considered.

There is one feature about these movements which is very remarkable, and which must have struck every observer, viz., the indefiniteness of the course of contraction, and the readiness with which it may be reversed or varied. If the protoplasm is abso-

* "Drysdale's Protoplasmic Theory of Life," p. 179.

lutely homogeneous, and therefore structureless, it is most difficult to conceive how this could be effected, while if the presence of contractile filaments could be demonstrated, the difficulty would be at once removed. Whether such filaments will ultimately be discovered in all protoplasmic bodies it is impossible to say, but we have evidence that in some cells such filaments do exist, and are contractile, and that in others a filamentous structure has been observed, although its function, if any, has yet to be determined.

Dr. Allman, in the address from which a quotation has already been given, pointed out and illustrated by numerous instances the fact of the close agreement that exists between the protoplasm of animal and vegetable cells, both in appearance and behaviour, under the influence of reagents. We may therefore refer to observations which have recently been made in animal cells, but at the same time it is interesting to note that this agreement between the two kingdoms is still maintained, and that we are not left to argue from analogy; that because certain appearances and phenomena have been observed in one, therefore they exist in the other.

In 1879 Professor Julius Arnold described the appearance and structure of a large number of animal cells, both normal and pathological, and found that in both classes "cells possess a complicated structure; the two constituents as ordinarily distinguished by us, the cell-body and the cell-nucleus, consist of a ground substance as well as of granules, sets of granules, and *filaments*; these latter may become very complicated in the more highly developed forms of cells," * and has no doubt that whatever future results may lead to, they will demonstrate that the structure of the cell is not so simple as it is ordinarily considered to be. In the same year Professor Fromman, treating of the vegetable cell, stated that he had detected in growing cells a thread-like, reticulated structure, both in the protoplasm and nuclei and in the chlorophyll bodies, and that these not only serve to connect the nuclei and chlorophyll bodies with one another, but that they pass from one cell to the next through minute crevices in the cell-wall. † With regard to these observations I would say, that so far as protoplasm and nuclei are concerned, I have not the slightest doubt that Professor Fromman is correct, as the structure described in the nuclei is most satisfactorily established, and the thread-like reticulation he refers

* "Journal Royal Micro. Soc.," vol. iii., p. 50.
† "J. R. M. S.," vol. iii., p. 475.

to in the protoplasm I have also seen. As to the chlorophyll bodies, he has in all probability noticed the appearance described by Pringsheim which they present after the removal of the *hypochlorin,* and which resembles in a striking degree that of one of the simpler and coarser spherical Polycistins.

In 1880 Herr Schleischer published an account of investigations he had made on living cartilage cells. He found that the protoplasm was formed of two elements, one almost homogeneous and liquid, the other solid and contractile. He also describes certain bodily movements of the nucleus, and says that they are due to the solid elements of the protoplasm, and to those alone.*

In the same year we have Professor Schmitz bringing forward corroborative evidence concerning the observations of Fromman's already referred to. According to him, "the protoplasmic body consists of a reticulated framework of extremely fine fibrillæ, varying much in their development;" "the intermediate substance between the meshes of the fibrillæ framework is a homogeneous fluid;" and "the framework of fine fibrillæ does not consist of rigid immotile fibres, but of a living motile protoplasm, which is continually undergoing change of form." †

MM. Treub and Mellink also, in treating of the embryo-sac of *Lilium bulbiferum,* describe a "ray-like disposition" of the protoplasm "around the nuclei, it being specially marked when the latter were in process of division." ‡ This also I am pleased to have seen, though not in the same species, and I strongly suspect that it has direct connection with the structure of the protoplasm.

Such is the evidence for the presence of structure in this living, growing substance, and taken together as referring both to animal and vegetable cells, I cannot help thinking that, while it does not *prove* its general existence, it is more than sufficient to cause us to suspend our judgment in the matter.

We pass on now to a consideration of the Nucleus, which hitherto we have only incidentally referred to. That this body is of great importance was, as we have seen, very early recognised, and the value of the cell was made to depend upon its presence or otherwise. As to the origin of the nuclei, and the formation of cells around them, various theories have been held, one of

* "J. R. M. S.," vol. iii., p. 408.
† "J. R. M. S.," series 2, vol. i., p. 475.
‡ "J. R. M. S.," series 2, vol. i., p. 621.

which was; that there is, in the first instance, a structureless substance present, sometimes fluid, sometimes more or less gelatinous. This substance possessed within itself power to occasion the production of cells. When this took place, the nucleus usually appeared first, and then the cell was formed around it. The substance in which the cells arose was named cell-germinating material, or cytoblastema.

This process was known as free cell-formation, and until quite recently was believed to be the one by which the first endosperm cells were produced within the embryo-sac of flowering plants. Such, however, Strasburger—who has for ever linked his name with the life-history of cells—has proved not to be the case, and that they, in common with all others, are derived from the division of pre-existing nuclei and cells.

In but few, if any, departments of biological science, has greater advance in knowledge been made during the last five years than has taken place with regard to the structure and division of nuclei. Essentially protoplasmic in its nature, it was believed to be devoid of structure, but denser and more highly refractive than the protoplasm in which it is enclosed. But during the last few years, owing to the labours of many observers, but notably Strasburger and Flemming in Germany, and Klein in England, the views previously held have been completely revolutionized.

Nuclei are now known to consist of two elements, differing from each other chemically as well as in appearance. The one is dense, the other is semi-fluid, the denser one being also more highly refractive. The first names proposed for them were nuclear-fluid and nuclear-substance respectively; but seeing that the one was in reality never a true fluid, another and more satisfactory nomenclature has been proposed. The best results—so far as the observation of the structure and behaviour of nuclei in vegetable cells are concerned—are obtained in tissues whose protoplasm has been fixed by means of absolute alcohol, and the sections stained with Hematoxylin; and in preparations so treated it is found that the nuclei are most beautifully stained, while all else either remains uncoloured or is tinted to a very small extent. And further it is found that in nuclei either preparing for or in process of division, only one of the elements is coloured, the other remaining colourless, the denser substance taking the stain intensely, the other refusing it. Here we have at least an indica-

tion of a clear chemical difference, whatever it may be. Taking advantage of this fact, and without any further reference save for purposes of distinction, it is proposed to call the denser element which eagerly takes the colour "Chromatin," and the one which refuses it "Achromatin."

The arrangement of the two nuclear elements is not always alike. Sometimes the chromatin presents the appearance of a distinct reticulation or network interpenetrating the whole of the nucleus; at others it is seen as distinct rods or filaments, while in nuclei which are at rest it sometimes seems as though it was diffused throughout the general substance. Another feature also is sometimes well shown, especially in those nuclei where the chromatin is seen as filaments, and that is the presence of a nuclear-membrane of chromatin, the rods and filaments running through the enclosed substance, and amongst them the spherical bodies, known as nucleoli, lying free. With regard to the latter, some doubt at present exists, both as to their nature and function; they take the colour, but not so intensely as the chromatin. Taking now a section, say through the integuments of a young ovule, prepared and stained as already described, and examining it with a power of between five and six hundred, we shall see most of the nuclei presenting an appearance somewhat like Fig. 1. This would at first perhaps be somewhat misleading, and you might decide at once that the darker parts were granules deeply coloured; but by careful and slow focussing up and down you will soon make out their true character. Were they granules, you would lose some, and others would come into view, but you will find that by watching one you do not lose it, but follow its course, which is generally more or less oblique, proving that it is a rod or filament, and what you first saw as dots or granules were really these filaments of chromatin in optical section. These points are best made out in the large primary nucleus of some embryo-sacs—for instance, of the tulip, from the integuments of the ovule of which plant these figures are taken. When a nucleus is about to divide, there is first growth, increase in size, and alteration of form; whereas it was, whilst at rest, more or less spherical, it now becomes ovoid, its chromatin filaments become much coarser, and the appearance is as Fig. 2. The filaments then straighten themselves out and arrange themselves more or less parallel to each other, as Fig. 3, and now contracting towards the centre of the cell as in Fig. 4, they eventually form a plate as in Fig. 5. This plate is the final phase of the first stage, and all that

has gone before has been progressive towards it. There is one feature which can now be seen, namely, the fibrillar arrangement of the clear element of the nucleus on either side of the chromatin plate, and through the remaining stage until the final division of the cell this appearance is presented in a most striking manner. We now come to the actual division of the nucleus. The plate which we have seen formed splits into two, not suddenly; commencing at the circumference, it gradually proceeds until we have two plates instead of one, lying near to and facing each other. This stage I have seen best in the spore mother-cells of *Equisetum*, and it is shown in Fig. 12. In the Tulip, as soon as the division of the plate has taken place, the filaments are again seen ranging themselves longitudinally and parallel, but now they are found to be in two sets, Fig. 6, and they recede from each other, as in Fig. 7, till they reach the extremity of the achromatin, when the ends of the filaments farthest from the centre unite, and we have the dyaster stage as shown in Fig. 8. During this time the striated appearance of the colourless portion of the nucleus, the Achromatin, becomes more marked, and henceforth claims greater attention. It is now seen as a continuous band uniting the two chromatin groups. The chromatin filaments now close up, the achromatin appearing to increase and become more defined. The two daughter nuclei now approach each other somewhat, the achromatin, bulging out between them, and at the same time a row of dot-like thickenings appear midway between the chromatin masses as shown in Fig. 9. These thickenings denote the position to be occupied by the division plate of the cell. Still this closing up of the chromatin continues, the bulging out of the colourless element also increases, till a condition shown in Fig. 10 is reached, this being taken just at the time when the cellulose plate has been deposited midway between the nuclei. These now recede from each other, take up a more or less central position in the daughter cells, and go into the resting condition.

Such is the complicated but most interesting process of cell division. How different it is from what used to be held! Instead of a simple structureless substance becoming constricted in the centre and finally divided, we have here a structure and character the meaning of which is as yet but little known, and the process of division is as complex as could well be imagined. Starting from the resting stage, it (the parent nucleus) passes through cer-

tain phases till the equatorial plate is reached; then passing again through the same phases, but in reversed order, they (the daughter nuclei) again reach the resting condition.

The figures assumed by the nuclei during division vary somewhat amongst the different classes of plants, but still in all essential particulars they agree. In Figs. 11 to 14 are shown the appearances presented by the two elements in the nucleus of the spore mother-cell of *Equisetum limosum.* You will notice how much more regular in outline and arrangement they are. It is needless to describe the process here in full, as it agrees with that given in the Tulip. I would, however, point out that in Fig. 13 you have two nuclei in process of division, one further advanced than the other, but in one the equatorial plate is shown in plan, and appears almost solid. The spore mother-cell is without a wall till the stage in Fig. 14 is reached, when cellulose is deposited around the cells, which have now become the spores.

That these structures and processes are of great interest and importance we must all admit, but at present it is impossible to say which of the two nuclear elements is to be looked upon as the efficient cause of the phenomena we have been reviewing. Is it the achromatin, as suggested by Flemming, which acts upon and causes the chromatin to pass through the varied figures in which we have seen it? or is it in the chromatin that the power resides, and by which it operates, imparting what may be called polarity to the colourless element, and so arranging it as has been described, and bringing about the final division by its agency? For an answer to these questions we must wait for more light.

DESCRIPTION OF PLATE I.

FIGS. 1-10.—From integument of ovule of *Tulipa Gesneriana.* Figs. 11-14. —Spore mother-cells of *Equisetum limosum,* all × 570.

FIG. 1.—Nucleus in resting condition.

FIGS. 2-10.—Successive stages in division of Nuclei.

FIG. 5.—Nuclear spindle with equatorial plate.

FIG. 8.—Dyaster stage.

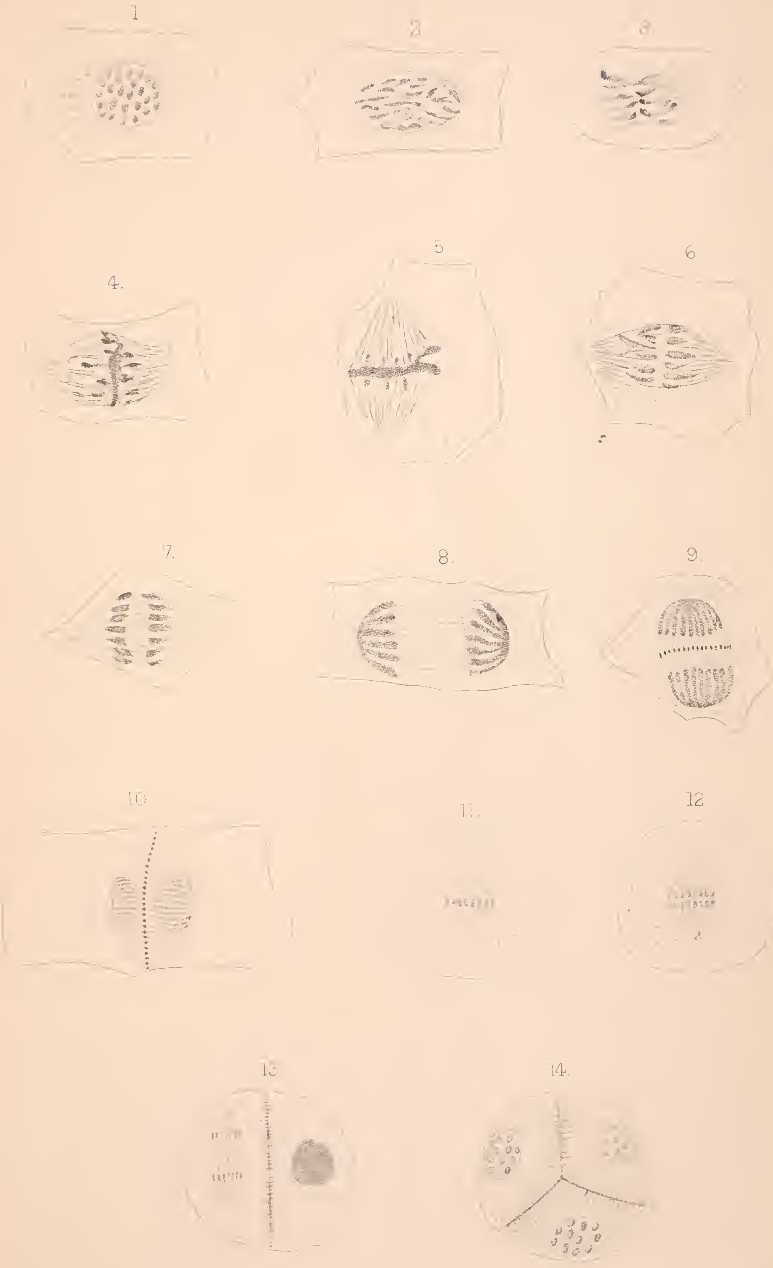
FIGS. 9, 10.—Appearance of Nuclear plate, showing position of future cell plate.

FIG. 11.—Nuclear spindle with equatorial plate.

FIG. 12.—Division of equatorial plate.

FIG. 13.—Equatorial plate seen in plan in one daughter cell, and further separation in the other.

FIG. 14.—Final stage, just prior to separation of spores.



H. Gilburt del.

Mintern Bros lith.

On an Improved Compressorium.

By J. D. Hardy.

(*Communicated December* 23*rd*, 1881.)

My object in constructing the compressor which I have shown in the accompanying drawing is to remedy, to some extent, the defects which I have found to exist in compressors as at present constructed. These defects are mainly the difficulty of regulating the pressure with exactness, the imperfect parallelism, and a deficiency of freedom of action, which causes great risk of losing or damaging the object under observation.

In the annexed figures I have shown two views of my improved compressor, Fig. 1 being a perspective view, and Fig. 2 an edge view.

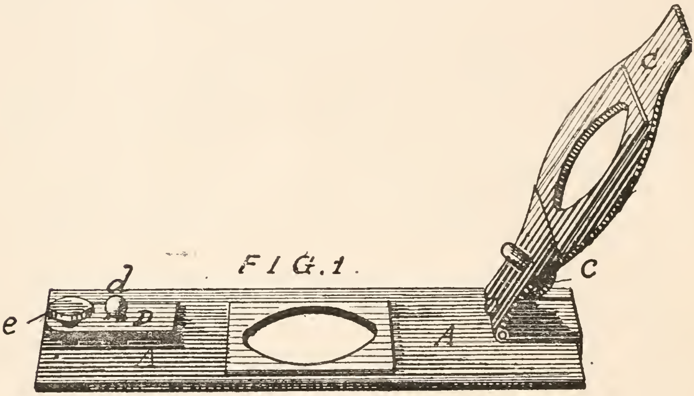
In these figures A is a brass plate, three inches long by an inch and a half wide, or thereabouts, in the centre of which a round hole is formed. At one end of the brass plate A is secured a bent spring B, of thin brass, and to this bent spring is hinged a second brass plate C, also formed with a round hole in its centre, and bevelled on the upper surface to admit of the full action of high powers. This second plate C will, when turned down, as shown in Fig. 2, overlie the plate A, and the two holes will correspond with each other. At the opposite end of the plate A to that to which the spring B is attached, a button D is mounted so as to be capable of turning freely, and also of rocking on the short stud pin *d*. The outer extremity of this button is bored and tapped to receive a small thumb screw, *e*. A similar thumb screw, *f*, is also fitted to the plate C, near its hinge joint.

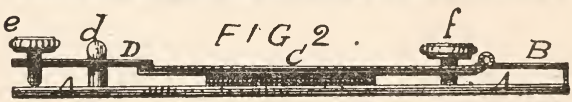
A thin cover-glass is cemented to the upper side of the plate A, so as to cover the central hole, and the under side of the plate C is similarly provided. I have shown in the figures these cover-glasses as square for the sake of clearness, but it is obvious that they may be either square or round, as may be found most convenient.

The mode of using this compressor is as follows:—The plate C is first turned down into place, and the distance that it is desired the glasses should be apart roughly adjusted by means of the screw *f*. The plate C may then be turned back, and the object placed on the lower glass; the covering plate is then again turned down and secured by turning the button D over it. By means of the two screws *d* and *f*, the pressure can now be regulated with the greatest nicety without any risk of damaging or losing the object under examination.

This arrangement admits of the glasses being easily cleaned and readily replaced by new ones when broken.

FIG. 1.





PROCEEDINGS.

August 26th, 1881.—Ordinary Meeting.

T. Charters White, Esq., M.R.C.S., &c., President, in the Chair.

The minutes of the preceding meeting were read and confirmed.

Mr. M. D. Northey and Mr. Eugene L. Roy were balloted for and duly elected members of the Club.

The following additions to the Library were announced, and the thanks of the Club voted to the donors:—

"Proceedings of the Royal Society" ...	from the Society.
"Journal of the Royal Microscopical Society"	" "
"Transactions of the Norfolk and Norwich Naturalists' Society"	" "
" " Geologists' Association"	" "
" " Hertfordshire Natural History Society"	" "
" " Birmingham Natural History Society"	" "
" " Epping Forest Naturalists' Field Club"	" "
" " Eastbourne Natural History Society"	" "
"On the Diatoms of the London Clay" (Reprint)	Mr. F. Kitton.
"Balfour's Comparative Embryology," Vol. II.	The President.
"Science Gossip"	from the Publisher.
"Northern Microscopist"	" "
"The Microscope in Medicine" (American) ...	" "
"American Naturalist"	in exchange.
" Monthly Microscopical Journal"	"
"Annals of Natural History"	purchased.
"Micrographic Dictionary," Part II. ...	"
"Schmidt's Atlas of the Diatomaceæ" ...	"

Mr. Heinrich Hensoldt (introduced by Mr. G. D. Brown) read a paper "On Fluid Cavities in Meteorites."

The President remarked on the value of the paper, and invited discussion. He inquired if the fluid had been examined with the spectroscope?

Mr. G. D. Brown said that having had the pleasure of introducing Mr. Hensoldt to the meeting, he wished to say that, without criticising the

paper they had just heard read, he considered it might be of considerable interest, and not altogether wide of their more special studies.

Mr. J. D. Hardy inquired if the sections had been examined with the polariscope, and whether the appearances might not be caused by "Brownian" movements?

Mr. T. H. Buffham thought that no proof had been given that the cavities contained carbonic acid. He doubted that any quantity of carbonic acid could be retained in such sections under the pressure required to liquify it. He thought that the contents might be water formed by a combination of hydrogen with the oxygen of the iron. The conclusion that the meteorite was part of a larger one that had been exploded was also against the general opinion regarding the formation of the asteroids and similar bodies. It had been proved that these could not have been produced by such an explosion, as the asteroids had no common node. In the neighbourhood of the sun there were millions of such bodies, space being filled with bodies of all sizes. No known power could separate the smaller fragments of an asteroid or meteorite from the larger. Meteorites were considered to be aggregations of smaller bodies, not the result of explosions.

Dr. Matthews asked if the cause of the high temperature of the meteorite was known?

Mr. Hensoldt, in reply, said that the movements of the bubbles were clearly not "Brownian," but were caused by variations in the atmospheric pressure. The same effect could be shown with a delicate spirit-level. The rapidity of the motion was in proportion to the smallness of the cavities. He had not been able to examine the fluid with the spectroscope, but had come to the conclusion from its behaviour that it must be either carbonic acid or some hitherto unknown substance of the same character. Cavities in basic lava had been found to contain carbonic acid. His investigations tended to support the explosion theory. The heating of meteorites was most probably caused by friction in their rapid passage through our atmosphere.

The President, in closing the discussion, referred to a paper "On the Identification of Liquid Carbonic Acid in Mineral Cavities," by W. N. Hartley, F.C.S., read before the Royal Microscopical Society (Monthly Mic. Journ., vol. xv., 1876, p. 170), and placed the volume on the table for reference. He called upon them to pass a cordial vote of thanks to Mr. Hensoldt for his elaborate and interesting paper.

A vote of thanks was carried unanimously.

The President announced the engagements for the ensuing month, and the Proceedings terminated with the usual Conversazione, at which the following objects were exhibited:—

Section of *Coprolite*	Mr. F. W. Andrew.
Floscularia	Mr. W. G. Cocks.
Head of Carpenter Bee (*Odynerus parietum*), showing organs of mouth in natural form and colour	Mr. F. Enock.
Fluid enclosures in a section of a Meteorite (in illustration of his paper)	Mr. H. Hensoldt.

Attendance—Members, 44; Visitors, 2.

September 9th, 1881.—Conversational Meeting.

The following objects were exhibited :—

Fungus on Mallow leaf......	Mr. F. W. Andrew.
Floscularia	Mr. W. Goodwin.
Amœba princeps, of very large size... ...	Mr. J. E. Ingpen.
Calcarina hispida	Mr. B. W. Priest.
Dental Exostosis, stained ; transverse and longitudinal sections	Mr. J. G. Tasker.
Section of Meteorite (?) with cavities containing carbonic dioxide (?) ...	Mr. H. J. Waddington.

Mr. W. A. Bevington sent from Rudesheim some specimens of vine leaves covered with the fungus "Kreusel krankheit."

Attendance—Members, 45 ; Visitors, 4.

September 23rd, 1881.—Ordinary Meeting.

T. Charters White, Esq., M.R.C.S., &c., President, in the Chair.

The Proceedings commenced at 8.25 p.m.

The minutes of the preceding meeting were read and confirmed.

The following gentlemen were balloted for and duly elected members of the Club :—Mr. Heinrich Hensoldt, Mr. Gerald Sturt, Mr. E. S. Whelpton.

The following donations to the Club were announced :—

"Report of the Croydon Natural History Society	from the Society.
,, ,, Chester Natural History Society"	,, ,,
"Science Gossip"	,, the Publisher.
"The Northern Microscopist" ...	,, ,,
"The American Naturalist" ...	in exchange.
,, ,, Monthly Microscopical Journal	,, ,,
,, ,, Journal of Microscopy"	,, ,,
"Annals of Natural History"	purchased.
"Grevillea"	,,
"Synopsis of Leidy's Rhizopods	,,
"Histological Demonstrations"	,,

The thanks of the Club were voted to the donors.

Mr. Ingpen exhibited and described Mr. Aylward's concentric turntable.

The President thought the turntable was very ingenious as regarded its mode of centring, but he was afraid it would not enable any one to put a fresh coat of varnish on an old slide which had originally been mounted out of the centre—this was a most desirable qualification.

Mr. Ingpen did not think there was any special contrivance provided for

uncentring, but a pair of springs were supplied which, on being fixed, converted it into an ordinary turntable.

Mr. F. Enock described a new device for protecting objects mounted in fluid from damage by external pressure. It consisted of a small metallic ring of angular section (┌) which fitted closely round the outside of the cell, and at the same time slightly overlapped the cover-glass, entirely closing in the rim. When made good with cement it gave great additional protection, and prevented the unsettling of the varnish and the escape of the fluid medium, which so frequently occurred as a result of careless handling. The metal rings would not greatly add to the cost of mounting, as they could be obtained for about 3d. per dozen at most of the opticians.

Mr. Ingpen inquired if Mr. Enock particularly preferred gold-size as a cement for fluid cells ?

Mr. Enock said that sometimes he used dammar, and at others the ordinary asphalt varnish, but thought that on the whole gold-size was best.

The President thought the idea was a good one, but whilst he agreed with what had been said as to the difficulties of this kind of mounting, he thought they should remember that glycerine would expand, and that unless they used a cement which was to some extent elastic, they would be apt to get the cells cracked.

The thanks of the meeting were returned to Mr. Enock for his communication.

Mr. W. H. King exhibited a specimen of the inflorescence of *Monstera deliciosa*, and described by means of blackboard drawings the growth and development of the plant. The plant from which the specimen had been cut was growing in England, and the fruit, which was said to be very luscious, ripened during the year following the appearance of the flower.

Mr. J. G. Waller said he made the acquaintance of the fruit of this plant at the dinner table in the course of last year, and could certainly say that it was most delicious, the taste being somewhat between that of banana and pine-apple. The seeds had been obtained, he believed, from South America, and were given by a lady to a vine grower in Madeira, by whom they were planted, and they throve so well there that the plant was now found all over the island. The introduction was due to this lady's son, who was a member of the Club.

Mr. King, in reply to a question, said that the inflorescence bore a good deal of resemblance to that of the common Arum, but both male and female flowers were found on the same spadix.

The thanks of the meeting were voted to Mr. King for his communication.

Mr. J. D. Hardy described some observations which he had made upon *Stentor polymorphus*, from which he had no doubt as to its being a further development of *Stentor viridis ;* his remarks upon the subject were illustrated by black-board drawings.

The President said a great deal might be done in this direction if they had a good growing-slide, which would enable the development of an or-

ganism to be easily followed. Until this was systematically done, they were not in a position to say whether many of the species with which they were acquainted were not transitional forms. His own belief was that many of them were; certainly this was a case in which they wanted more light upon the subject.

Mr. Washington Teasdale said that with regard to the question of keeping objects alive, he had often been struck by the simple way in which Mr. George Chantrill, of Liverpool, kept them; he had a number of zinc shelves which he kept under a bell glass, and the requisite supply of moisture was supplied to the slides by means of a quantity of thick felt which was kept constantly saturated. In this way Mr. Chantrill was accustomed to keep his objects alive for many months, examining and making drawings of them with extraordinary patience. He had come to the conclusion that many organisms did change from one form to another.

Mr. Teasdale said that he had been asked to mention at the meeting of the Club that the Yorkshire Naturalists' Union had arranged for a Fungus Foray to be held at Leeds on the last day of September and first of October. It was intended to hold an exhibition of fungi, and he invited the members of the Club to assist by the exhibition of micro-fungi or other specimens on that occasion.

The President read a paper "On the Injection of Specimens for Microscopical Examination."

The Secretary moved a vote of thanks to the President for his paper, which was put and unanimously carried.

The President having briefly responded, announced the meetings for the ensuing month, and the proceedings terminated with the usual Conversazione, at which the following objects were exhibited :—

Sections of leaf and stalk of *Rhododendron*, double-stained	Mr. F. W. Andrew.
Hydra fusca	Mr. E. Dadswell.
Sexual organs of male wasp	Mr. F. Enock.
Alcyonella flabellum, from Highgate... ...	Mr. W. Goodwin.
Young Sole, polarized	Mr. H. R. Gregory.
Stentor polymorphus, &c.	Mr. J. D. Hardy.
Anguis fragilis, tactile (?) corpuscles of the penis	Mr. E. T. Newton.
Suckers of *Cuscuta epithymium*, applied to leaves of Heather ... ... Cyclosis in *Closterium* ... ... *Drosera longifolia*	Mr. J. W. Reed.
Freshwater Sponge, showing circulation ...	Mr. F. Wood.

Dr. T. Partridge, of Stroud, distributed specimens of *Argulus foliaceus*.

Attendance—Members, 56; Visitors, 5.

October 14th, 1881.—Conversational Meeting.

The following objects were exhibited :—

Pediculus capitis—the tracheal system partially injected with carmine ...	The President.
Section of Stem of Geranium, polarized ...	Mr. F. W. Andrew.
Sections of Coccidium of *Rhodymenia ciliata* (Marine Alga) showing spores *in situ*	Mr. T. H. Buffham.
South African Fly, showing curious antennæ...	Rev. H. J. Fase.
Exuvium of Leaf Insect in a Spider's Web ...	Mr. F. Fitch.
Calyx of *Thymus vulgaris*, from Nice, showing white hairs and oil-glands ...	Mr. H. G. Glasspoole.
Foot of *Dytiscus marginalis*	Mr. H. R. Gregory.
Seed-vessel of *Rosa canina*, showing hairs ...	Dr. Matthews.
Parasite of Skate, *Crustacea suctoria*, female, with egg-sacs ...	Mr. A. D. Michael.
Isthmia nervosa, front and side views ...	Mr. H. Morland.
Sections of spathe and peduncle of *Monstera deliciosa*	Mr. J. W. Reed.

Attendance—Members, 68; Visitor, 1.

October 28th, 1881.—Ordinary Meeting.

T. Charters White, Esq., M.R.C.S., &c., President, in the Chair.

The minutes of the preceding meeting were read and confirmed.

Mr. W. P. Reynolds and Mr. V. Simons were balloted for and duly elected members of the Club.

The following additions to the Library and Cabinet were announced :—

"Proceedings of the Linnean Society" ...	from Mr. T. C. White.
"Journal of the Royal Microscopical Society"	„ the Society.
"The Northern Microscopist"	in exchange.
"Report on the Methods of Research in use at the Naples Aquarium" ...	
"The American Naturalist"	in exchange.
"The American Monthly Microscopical Journal"	„ „
"Annals of Natural History"	purchased.
"Quarterly Journal of Microscopical Science"	„
"Challenger Reports"	„
"Floating Matter in the Air" (Tyndall) ...	from Mr. J. W. Groves.
17 Slides, illustrating subjects treated by Dr. Carpenter	„ Mr. T. C. White.

The thanks of the Club were voted to the donors.

Mr. H. Epps exhibited and described an old solar microscope manufactured by Culpepper probably about 1750, which had been lent to him by a friend for the purpose.

Mr. Ingpen said it was evidently a very favourable specimen of the solar microscope, but in its present condition it was of course unsuited for other purposes; probably, however, it would be found that the optical portion was made to detach so that it might be adapted for use in the ordinary way.

The President, in proposing a vote of thanks to Mr. Epps, expressed his feeling that however interested they might be in what had been so well done so long ago, they might congratulate themselves upon the greater capabilities of the microscopes in use at the present time.

Mr. J. W. Groves exhibited a freezing microtome, which he described as an improvement upon the one which he had exhibited at the April meeting of the Club. The arrangement for freezing by means of ether spray remained practically the same, but the apparatus was fitted so as to be clamped to the table, and was provided with a sliding tube which made it available for use with substances which required to be embedded in wax. This holder was raised as required by a divided micrometer screw; the razor was also fitted into an improved frame, so constructed that it could be worked readily in any direction, whilst the inclination of the edge of the blade to the object could be regulated as required; the frame in which the razor was clamped was fitted so as to move in a true plane on the face of the two steel runners fixed on either side of the stage. The arrangement was further described by means of drawings on the black-board.

The President thought the apparatus was very beautifully made and contrived. He inquired whether it took long to freeze objects in that way, and what amount of danger attended the use of such an apparatus at night in proximity to a light?

Mr. Groves, in reply, said he had on the former occasion, when he exhibited the apparatus, explained that there could be no danger in using the apparatus, because a tube was provided which carried the whole of the waste ether into the open air through a window or otherwise. He also then showed that if the bellows provided were not sufficiently powerful the spray could be driven by means of a contrivance worked by the foot or by any other motor. He could perfectly freeze a specimen in $1\frac{3}{4}$ minutes, and that with the cheapest methylated ether at sp. gr. 73.

Mr. J. W. Reed inquired if the machine could be used with ice and salt, as he thought that freezing with ether would be inconvenient in private houses and in some places it might be difficult to obtain.

Mr. Groves said this machine could not be used with ice and salt; the old form of it *was* so used, but this improvement had been made as rendering the process far more convenient. The only inconvenience likely to arise was from the escape of the ether vapour into the house, but only a very small quantity was likely to do so during the act of filling the reservoir. The objection, on the other hand, to ice and salt was that in most parts of the country ice was difficult to procure at any reasonable price, and in many places it could not be had at all, whilst ether could be carried and kept anywhere, and was always ready for use. As regarded the comparative expense of the two methods, he thought the cost of the ether was about the same as that of the ice without the salt. The old machine could be

procured from Mr. Swift by any one who still preferred to use ice and salt.

The President said that the Secretary had suggested that he should say a few words as to the plan on which he had acted in presenting some slides to the cabinet that evening. In his Presidential Address he had suggested the desirability of having portions of a book on microscopy illustrated by a series of slides with references. He had endeavoured to carry out this idea to some extent by presenting to the Club 17 slides of subjects treated of by Dr. Carpenter, and he hoped that some other members would take up similar subjects and illustrate them for the benefit of the Club. He felt sure that such collections would prove of great help, especially to those who were beginning to work up any subject.

Mr. J. W. Groves thought the suggestion was an extremely good one, and hoped it would be the means of stimulating members to do something for the Club. He was sorry to say that there were many who never seemed to do anything, but he hoped that after what had passed every one would try to assist. He did not think that it would be difficult to illustrate an entire work if members would set about it in the right way.

Mr. Deby exhibited and described an apparatus for obtaining monochromatic light for use with the microscope; the beam of light from the lamp being condensed by a large bull's-eye, was passed through a slit and refracted by means of a bisulphide of carbon prism. A simple contrivance enabled any portion of the spectrum to be employed for purposes of illumination.

The President inquired if this method possessed any special advantages over the solution of copper and ammonia which had been recommended?

Mr. Deby said the light obtained by means of the prism was certainly purer.

A member said he used a large hollow bull's-eye, containing bisulphide of carbon, which he thought would be of further advantage, as giving a much larger dispersion.

Mr. Ingpen considered the light of the pure spectrum better than that obtained by passing white light through any coloured mixture. In the case of finely marked objects the resolving power of objectives was greater with blue than with red light. A simple method of obtaining a brilliant monochromatic light was very desirable under many circumstances. It would be valuable with objects mounted in substances of very high refractive index, to which attention had recently been called. It was impossible to make use of the entire aperture of large angled oil-immersion lenses upon dry-mounted lined objects, and when mounted in balsam the markings became almost invisible. It was therefore very desirable to mount them in media of much higher refractive index, and the object became more and more visible in proportion to the difference between its own refractive index and that of the medium in which it was placed. He should like to direct the attention of some of their chemical members to this subject, with the view of finding out what clear substances of high refractive index were available for this purpose, and in which not only diatoms but his-

tological specimens could be safely mounted. Phosphorus was troublesome, and not very satisfactory for the purpose, but if they could find some suitable fluid which had an equally high refractive index, it would be of great value. Mr. Stephenson had, amongst other objects, mounted a Podura scale in phosphorus, and found that the effect produced was an inversion of its usual appearance in air.

Mr. Julien Deby said he had mounted a good many objects in monobromide of napthaline, and could say from experience that it was of no good whatever except in connection with homogeneous immersion lenses. He could not, however, recommend it even for them.

Mr. Ingpen said there were two distinct points to be borne in mind in mounting objects in these substances, one being that they enabled the whole of the large apertures of the oil-immersion lenses to be employed, and the other that they increased the visibility of the objects themselves.

The President said the members would no doubt be glad to hear that they were favoured by the presence of their distinguished honorary member, Mr. Kitton, of Norwich, to whom they would, he was sure, accord a hearty welcome.

Mr. Kitton acknowledged the compliment paid to him by the President, and expressed the pleasure he felt at being present on that occasion.

The thanks of the meeting were voted to those gentlemen who had favoured them with communications, and the proceedings terminated with the usual Conversazione, at which the following objects were exhibited :—

Rectal papillæ of Earwig, Flea, and Blow-fly...	The President.
Section of Coral with Foraminifera, polarized	Mr. F. W. Andrew.
Fructification in *Plocamium coccinium* ...	Mr. W. G. Cocks.
Pleurosigma formosum and *P. fasciola*, mounted in phosphorus	Mr. T. Curties.
Objects exhibited by Monochromatic Light ...	Mr. Julien Deby.
An old Microscope, by E. Culpepper, *circa* 1750	Mr. H. Epps.
Section of Shell of Brazil-nut	,,
Stem of White Water-lily, stained	Mr. W. Goodwin.
"The Ginger-beer Plant"...	Mr. J. D. Hardy.
Pleurosigma attenuatum, mounted in monobromide of napthaline	Mr. J. E. Ingpen.
Various vegetable sections	Dr. Matthews.
Wing of *Tabanus bovinus*, &c.	Mr. T. S. Morten.
Section of Ovule of *Ulmus*	Mr. J. W. Reed.
Larva of *Corixa*	Mr. F. Wood.

Attendance—Members, 79 ; Visitors, 10.

November 11th, 1881.—Conversational Meeting.

The following objects were exhibited :—

Section of Eye of Water-beetle	Mr. F. W. Andrew.
Ceramium rubrum (Marine Alga) from Teignmouth	Mr. T. H. Buffham.
Polynema ovulorum (the Fairy-fly), female, one of the most minute insects known	Mr. F. Enock.
Sphagnum acutifolium, from Keston	Mr. H. G. Glasspoole.
Flea, female, showing the muscular structure	Mr. W. Goodwin.
Aspidogaster conochila (Trematode Worm) from alimentary canal of the Freshwater Mussel	Mr. J. W. Groves.
Bryozoa, various and new species from Tasmania, Victoria, &c.	The Rev. J. J. Halley, V.P. Microscopical Society of Victoria.
Head of Spider, *Salticus scenicus*	Mr. G. Hind.
Patella (Nacella) pellucida	Mr. A. D. Michael.
Theine Crystals from the Tea Leaf, polarized	Mr. T. S. Morten.
Amphipleura pellucida, shown with Powell and Lealand's oil-immersion 1-12th, Num. ap. 1·428. Direct light with full aperture of achromatic condenser ...	Mr. E. M. Nelson.
Raphidotheca Marshall-Hallii (Sponge) ...	Mr. B. W. Priest.
Section of petiole of *Salisburya adiantifolia*...	Mr. J. W. Reed.
Pond Life	Mr. H. J. Waddington.
Head of Wild Bee *(Halictus ?)*	Mr. F. Wood.

Attendance—Members, 54; Visitors, 8.

November 25th, 1881.—Ordinary Meeting.

T. Charters White, Esq., M.R.C.S., &c., President, in the Chair.

The minutes of the preceding meeting were read and confirmed.

The following gentlemen were balloted for and duly elected members of the Club :—Mr. Walter H. Coffin, F.C.S., &c., Mr. George S. Dixon, Mr. Reginald T. G. Nevins, and Mr. Robert Wyatt.

The following donations were announced, and the thanks of the Club voted to the donors :—

" Proceedings of the Royal Society " ...	from the Society.
" Journal of the Linnean Society " ...	Mr. T. C. White.
" Science Gossip "	from the Publisher.
" The Analyst "	" "
" The Northern Microscopist "	in exchange.

"The American Naturalist"	in exchange.
" "Monthly Microscopical Journal"	" "
"Van Heurck's Synopsis of Belgian Diatoms"	purchased.
"Annals of Natural History"	"
A part of Kent's "Infusoria"	"
Six Slides	Mr. H. F. Hailes.
One Slide	Mr. J. W. Groves.

Mr. Goodwin exhibited and described the action of his Growing slide.* This was formed of a triangular glass plate, each side being 3 inches in length, supporting a circular thin glass cover $1\frac{1}{2}$ inches in diameter, kept in position by three ebonite studs round which indiarubber bands were passed. The cover-glass was perforated in the centre by a small hole surrounded by a brass ring. Through this hole objects were introduced, and water dropped from a vessel by a thread of soft cotton. Three similar threads under the edges of the cover drew off the superfluous water. The objects could be readily examined in any part of the circumference of the cover. Mr. Goodwin showed the plan adopted by him for keeping a number of the slides in action at the same time. In reply to questions, Mr. Goodwin further stated that the object of the ring was to keep the cover together and to strengthen it as well. The large size of the cover glass was intended to give plenty of room for objects, affording as it did nearly two square inches of space; whilst the glass was sufficiently thin to admit of a $\frac{1}{8}$-in. objective being used.

Mr. Chas. Stewart thought it a most excellent slide, but suggested that if glass stops were used instead of vulcanite, they would not be so likely to scale off from variation of expansion.

Mr. W. H. Gilburt read a paper "On the Structure and Division of the Vegetable Cell," illustrating the subject by a series of coloured diagrams.

Mr. C. Stewart, in reply to the President, said that Mr. Gilburt's account had been so clear that it left nothing to be desired, and he had nothing to add to it. In the animal cell the same steps were gone through; the process was best seen in the large nuclei of malignant tumours which divided into 2, 3, or 4, the steps being exactly the same. He thought, however, that he must object to the term "fluid" as it seemed to be used in the paper. If they took the term as physicists used it, it was correct, for it was not the extent of the motion which made the difference between the two states, but rather that in the case of a solid the motions were fixed as regarded a certain centre, whilst in the fluid the centre was not fixed, but there was a constant migration of particles, because the centres themselves were in motion. He might also say that these examinations of vegetable cells were not difficult; it only required some rapidly developing cells hardened in spirit and stained with logwood to see all the things which they had been hearing about.

The President inquired if Mr. Gilburt's attention had been drawn to

* This instrument was first described by Mr. T. C. White, at the meeting of the Royal Microscopical Society on the 9th of November, 1881, and a description and figure of it will be found in the "Journal of the Royal Microscopical Society," ser. 2, vol. I., p. 946.

certain reticulations which occurred in *Protococcus pluvialis* when stained with osmic acid. There seemed to be no structure until they were stained, and then surrounding the nucleus were seen what looked like fine canaliculi.

Mr. Gilburt said he had observed this feature in *Protococcus*, but did not think it was altogether the same as the President had described; he thought the reticulations were simple protoplasmic filaments which acted as guide ropes to keep the nucleus in the centre.

Mr. Stewart said he quite agreed with this view; they had their parallel in the lines of *Volvox* by which they were kept in position.

The thanks of the meeting were voted to Mr. Gilburt for his paper.

Announcements of meetings for the ensuing month were then made, and the proceedings terminated with the usual Conversazione, at which the following objects were exhibited:—

Rare Foraminifera	Mr. F. W. Andrew.
Freshwater Sponge (living)	Mr. W. G. Cocks.
Head of Wild Bee, *Andrena fulva*, male ...	Mr. F. Enock.
Anthophysa Mullerii, &c.	Mr. J. D. Hardy.

Attendance—Members, 66; Visitors, 6.

December 9th, 1881.—Conversational Meeting.

The following objects were exhibited:—

Larva of *Corethra plumicornis*, polarized ...	The President.
Cuticle of Oleander	Mr. F. W. Andrew.
Palate of Cuttle Fish, *Sepia officinalis* ...	Mr. W. R. Browne.
Polysiphonia fibrata, Marine Alga, in fruit ...	Mr. T. H. Buffham.
Tongue of Sand Bee	Mr. A. Button.
Epistylis operculata (?) very large and rare...	Mr. W. G. Cocks.
Section of leaf of *Iris germanica*	Mr. H. Morland.
Actinospheria Eichornii	Mr. T. S. Morten.
Pleurosigma formosum, with 1-12 oil-immersion objective and central light ...	Mr. E. M. Nelson.
Demodex folliculorum, from mange in dog; Jaw of Cobra	Lt. Col. O'Hara.
Distichopora coccinea, Coral, showing the styles *in situ*	Mr. B. W. Priest.
Section of Samara of *Fraxinus excelsior* ...	Mr. J. W. Reed.
Cuticle of interior of pitcher of *Nepenthe* ...	Mr. G. Sturt.
Algæ with Diatoms *in situ*	Mr. H. J. Waddington.
Hæmatopinus piliferus ?	Mr. F. Wood.

Attendance—Members, 50; Visitors, 2.

December 23rd, 1881.—Ordinary Meeting.

T. Charters White, Esq., M.R.C.S., &c., President, in the Chair.

The minutes of the preceding meeting were read and confirmed.

Mr. J. G. E. Bolton, M.R.C.S., and Mr. Claude C. Claremont, M.R.C.S., were balloted for and duly elected members of the Club.

The following additions to the Library and Cabinet were announced:—

"Journal of the Royal Microscopical Society"	from the Society.
"Proceedings of the Watford Natural History Society"	" "
"Popular Science Review"	" the Publisher.
"Science Gossip"	" "
"Analyst"	" "
"Northern Microscopist"	" "
"American Monthly Microscopical Journal"...	in exchange.
"Annals of Natural History"	purchased.
"Micrographic Dictionary"	"
"Davis's Practical Microscopy"	"
Twelve Slides—Australian Bryozoa... ...	Rev. J. J. Halley.
Four Slides, showing method of Wax-cell Mounting	" "

The thanks of the meeting were voted to the donors.

The Secretary referred to the recent death of Mr. Wm. Mogenie, one of the oldest members of the Club, and well known for his great mechanical ingenuity and knowledge of practical microscopy. He would long be remembered by many who had availed themselves of his skilful and ready help. His portable microscope was in very extensive use. Personally his amiability and kindness endeared him to a large circle of friends.

Dr. Matthews said that they had also suffered by the death of Dr. Ramsbottom, to whose influence might be attributed his own connection with the Club. He was a thorough worker with the microscope; indeed, he never saw a more ardent student in the examination of organic life. He would only add that death had thus terminated a friendship which had extended over 38 years, and had left a void which would not be easily filled.

The President was sure that the remarks which had just been uttered would find an echo in every heart.

Mr. Ingpen said their regret at the loss of Dr. Ramsbottom would not be diminished by the fact that he had for some time retired from membership with them.

Dr. Matthews said that his withdrawal was solely due to physical incapacity; his friend had suffered from hæmorrhage of the retina, and was so afraid of losing the sight of his other eye that he had for some time been obliged to give up all microscopical work.

Mr. A. D. Michael said he wished to make a few observations upon an object shown under a microscope in the room, but he had found that

Dr. Matthews had hit upon the same plan, so that he hoped that what he had to say might be considered as a joint communication. The object to which he referred was shown under polarized light, and he wished to suggest that polarized light might be of use as an addition to staining for vegetable and some animal substances, as it seemed to differentiate tissues somewhat in the same way. In practice it might be found to have its disadvantages, but it might have its advantages. No special preparation of the tissues was required, and the conditions were more natural than if they had undergone the process of bleaching and staining. Then it would be possible, when they had a known selenite, always to repeat the same effect when required, whereas staining frequently faded, and if there were any doubt as to the meaning of what was seen, the effects could be altered, and results secured that would be unattainable with the fixed effects of double staining. There was, of course no difficulty in getting triple staining, or producing various colours, but the object which he had shown was as if stained with a single colour only. He wished also to say that the object was shown with oblique polarized light on a black ground. He had heard some discussion as to the best means of obtaining polarized light on a black ground, and had heard it suggested that the results depended entirely on the object, that it was to be obtained only now and then in the case of certain objects which had a capacity for it, also that it depended on the size of the polarizing prism and other causes. No doubt these things did affect it to some extent, but he was of opinion that the effect was largely a question of what the object was mounted in. He did not find that Canada balsam was the best medium; in fact, the best effects were obtained by mounting in glycerine, when there was very little difficulty in making out the details, and the object looked brighter upon a blacker ground as contrasted with its appearance when mounted in balsam. He thought the idea would be found worth attention, especially where it was desirable to examine objects under various conditions of direct and oblique light.

The President said they must all feel very much obliged to Mr. Michael for this communication, but so far as he was concerned, he had always found a good deal of difficulty in using polarized light on objects mounted in glycerine.

Dr. Matthews said he had but little to add to what Mr. Michael had said so well. On one point, however, as to the superiority of glycerine over balsam for this kind of examination, his experience was rather the reverse of Mr. Michael's. Whether this arose from any difference in the objects he could not say, but he thought that the effect was probably due to some difference in the density of the objects; the only way of settling the point would be to mount the same object in both ways. He should also say that if they got extremely oblique light, they got also fringes of colour, probably owing to diffraction. Mr. Michael had been very successful in getting dark ground illumination, but there seemed to be some curious effect produced by a spot lens, less colour being produced in that way than without, although it might have been supposed that the contrary would be the case. As to the differentiation of tissues, precisely the same effects were produced as

by staining, but with the advantage that a harmonious appearance was always produced, whereas with staining the selective power caused differences of colour which were not always harmonious.

Mr. Stewart said he had not made any researches into polarized light as applied in this oblique direction; it appeared, however, that it might be advantageous, but without having experience of its working it was exceedingly difficult to say much about it. He wished to inquire what was the position of the selenite; he presumed that it was put with its plane parallel to that of the object.

Mr. Michael said it was placed in the ordinary way.

Dr. Matthews said that he had made some sections of ovaries of plants which proved to be too thin to produce any effect. He afterwards gave them to Mr. Ingpen, who he believed could get no coloured effects from them; he should like Mr. Stewart to see them. So far as he had tried, no selenite thick or thin would differentiate them on the black ground.

Mr. Stewart thought this would probably be owing to the very slight tension in the cells; in the ordinary thickened cells they would be much more likely to get colour than in rapidly built cells such as those of the ovaries. The most delicate colour to use for such a purpose would be the blue of the third series, which was rather difficult to obtain; it was a blue the value of which consisted in the fact that a very slight difference of thickness would replace it by emerald green or red, so that a very slight degree of tension would suffice to produce colour effects.

Mr. Ingpen said he put the specimens mentioned by Dr. Matthews under his microscope in polarized light; he could not use the particular selenite which had been referred to, but he failed to obtain any effect with these thin sections, though with thicker sections he got a similar effect to that which Mr. Stewart had described. He was in favour of mounting vegetable tissues in glycerine. He had mounted many in glycerine jelly, and with that medium he obtained a very delicate reaction.

Dr. Matthews said he had found this method very useful in examining morbid tissues; in looking at a specimen of epithelioma he found that the cells showed the black cross as in the starches.

Mr. Stewart said that the only conditions necessary to show the black cross were to have lines of strain either radiating from the centre or running concentrically; it did not matter what the nature of the structure was so long as these conditions existed; so that if they had epithelial cells either wrapped round a cylinder or radiating from a point, they would get this effect at once without doubt. Mr. Stewart then, by means of blackboard drawings, explained more fully the production of the black cross in the two ways referred to.

The thanks of the meeting were unanimously accorded to Mr. Michael, Dr. Matthews, and Mr. Stewart for their remarks.

Mr. J. D. Hardy exhibited and described an improved Compressorium.

The President said there could be no doubt that this form of compressor obviated the disagreeable squeezing-out so often complained of.

Mr. Fox inquired what was likely to be the cost of it.

Mr. Hardy thought that it might probably be made for about 10s.; the one he exhibited had been made only for his personal use.

Mr. Ingpen hoped Mr. Hardy would excuse him for hinting that this came rather near to Mr. Wenham's paraboloid compressor; the method of hinging the cover was certainly a great improvement.

Mr. Hardy thought it made all the difference whether it worked on a hinge or on a pivot.

Mr. Ingpen said that for use with the paraboloid the lower glass should be made as nearly flush with the base-plate as possible; many compressoriums were unsuitable in this respect. In Abbe's condenser the top lens came up almost to the surface of the stage. A drop of water between the lens and the slide gave a blacker ground. If he were right in his idea that Abbe's condenser was *the* condenser of the future, those who were devising new forms of apparatus would do well to bear this in mind. The compressor exhibited by Mr. Hardy was very beautifully made, and quite capable of performing all that was claimed for it.

Mr. Michael said that he regarded the substitution of a hinge for the pivot as a great point, the pivot being very liable to damage the specimen by slipping; for when they had a delicate object to examine they must leave it wherever it might be well displayed. He thought, however, that the screws would be likely to interfere with the free movement of the objective over them.

Mr. Hardy said he had used it with a ⅛-in. objective.

Dr. Matthews said there was another form of compressorium which had the merit of moving with a parallel motion—he referred to the Ross form—it was impossible with this instrument to destroy an object by lateral motion, whilst the field was large enough to allow of the examination of an object even if it did not happen to be near the centre.

Mr. Ingpen said he had used this compressorium for years, and considered it to be one of the most useful. With regard to keeping lively objects in the middle of the glass, Dr. Hudson had adopted the plan of surrounding rotifers with a few threads of cotton wool, which he found very useful in preventing them from straying about the field.

Mr. Stewart said he had often used cotton wool in examining rotifers and had found it exceedingly useful; but prepared cotton wool, from which all fatty matter had been extracted, should be used for the purpose.

The thanks of the meeting were voted to Mr. Hardy for his communication, and the proceedings terminated with the usual Conversazione, at which the following objects were exhibited:—

Head of a House-spider, *Ciniflo similis*, male	Mr. F. Enock.
Bamboo fibre, polarized	Mr. H. R. Gregory.
Volvox globator, infested with *Notommata parasita*	Mr. J. E. Ingpen.
Section of *Serjanus*, illustrating the use of polarized light as a means of differentiation instead of double staining ...	Mr. A. D. Michael.

Attendance—Members, 37; Visitors, 2.

Sand.

By J. G. Waller.

(*Read January* 27, 1882.)

A grain of sand is one of the smallest of visible atoms, and as such passes into the language of metaphor. The aggregation of sand, as a symbol of untold multitude, is probably familiar to every language upon earth. In the operations of nature, working about us, we are ever being astonished at the minuteness of an individual agent towards a mighty end. So it is with sand, not only as it is working now, but as it has worked in illimitable ages past. The attrition of hard particles—silex—whether produced by storm floods, river torrents, or the tempestuous waves of the ocean, plays a part in its production, blocking up estuaries, and forming at the mouths of rivers dangerous shoals. This is mostly shown by those grand rivers of the earth draining large continents, and not tidal. But at the mouth of our own Thames, which is tidal, and a mere pigmy in comparison, we have large sandy deposits, often fatal to the mariner. Thrice has our great poet named the "Goodwins," and in "The Merchant of Venice" it is spoken of as "a very dangerous flat and fatal, where the carcasses of many a tall ship lie buried."

Then there are the vast sandy deserts, like dry oceans, also disturbed with moving waves and storms, overwhelming whole caravans of merchants or of pilgrims, who leave behind them a trail of whitened bones. Besides which it has its floods, as we call those moving sands lifted by the wind, and which in Egypt have encroached upon that fertile oasis, burying many of its ancient and renowned cities, whose monuments would seem almost to defy the hand of time. Nor are we without these phenomena in our own country, as the entombed church of Piranzabuloe, in Cornwall, testifies. But one of the most remarkable of these sand floods occurred in 1688, on the borders of Suffolk and Norfolk, and which is fully described by a gentleman, named Wright, a great sufferer by its destructive influence, in the early numbers of the Philosophical Trans-

actions of the Royal Society. It is too long to insert here in full, I will therefore briefly give you some of the facts.

It began at the small town of Lakenheath, where some sand-hills, covered with scanty herbage, got denuded of this by the wind blowing tempestuously from the south-west. These sands, lying on the chalk, belong, as I believe, to the series called by geologists the "Thanet sands." At first, about ten acres of ground got covered, but before the flood had advanced four miles it had overwhelmed one thousand. This visitation continued for many years, in spite of all attempts to arrest its progress. After twelve years had passed away, its first real obstacle was descending a valley, but it then ascended the opposite hill, entered the town of Downham, destroying several houses. The house of the narrator was almost buried in sand, which had mounted up to the very eaves of his outhouses. It partially filled the little river Ouse, and interfered with its navigation; and it was only conquered by years of sedulous care and enormous labour.

But it is in the formation of this earth's crust that the mighty power of sand is shown in enormous sedimentary deposits; the Old Red itself being estimated at 10,000 feet in thickness, added to which are others still earlier, and many that carry us upwards to the Tertiary system, where I propose particularly to enter and discuss our subject. What is this sand, so ubiquitous, so vast in its aggregations? A writer on "Beach Pebbles" put the question to a traveller from the great desert, in respect to which he answered, "Powdered quartz."*

But it is the sand of our coasts in which the special problem for discussion lays, and more particularly that on our eastern and southern shores, where are beaches of shingle fed from the débris of the upper chalk.

If we take a diagonal line from the estuary of the Exe to the Humber, east of it lays the large chalk formation of England. Sometimes it shows itself in rearing lofty white cliffs, by which our country obtained the name of "Albion;" at others it is only known by its ruins, and these have an extensive admixture of other deposits. Nevertheless, its bones, it may be said, are everywhere left behind in the dense flint shingle. These beaches are often many square miles in extent, shutting up ancient estuaries, which are known to have

* "Beach Rambles in Search of Seaside Pebbles and Crystals," by J. G. Francis, B.A., p. 107.

been navigable in historic times. But besides these accumulations by the sea-shore, we are well familiar in the great London basin of deposits of this same shingle with intercalated layers of sand, and the gravel, with its ferruginous hue, known to all for its use in our garden walks. This last, the most superficial of such deposits, caps the London clay over a large part of the metropolitan area. There is another earlier, known as the Bagshot sands, of which Hampstead Heath gives us an example easy for examination. Proceeding downwards, we pass through the vast mass of the London clay, and come to the Pebble bed, well represented at Blackheath, and well named for its small rounded pebbles, like marbles of various sizes, and mixed with this is sand. All these pebbles are of chalk flint. Deposits, more or less mixed with sand, succeed these, until we arrive at the "Thanet sands," lying on the chalk. Of what material, then, are all these sands, and wherein derived is the question proposed to this Society.

Of course the *primâ facie* view is that they naturally arise from the attrition of the flint. Nothing is more apparently obvious. Away from the region of the chalk flint, our coast sand is mostly composed, as we might imagine, of the débris of the adjacent cliffs or rocks, or from other prolific but neighbouring sources of supply, such as shells of molluscs, or calcareous particles of the remains of various zoophytes, as, for instance, at Land's End, and other parts of Cornwall. After we pass westwards of the estuary of the Exe, chalk flint is of rare occurrence on our coasts, although an outlier of the chalk débris may be seen west of but close to the Teign.

Now then we will proceed to see how far this question belongs to us as a Microscopical Society. Let us take a pinch of sand out of a washing down of a road paved with gravel, after storms of rain, and submit the same to the microscope; or, to be certain in our experiments, let us pound up some chalk flint finely. Our examination of it will show us that the flint has a granular appearance, and does not polarize.* Let us now take a piece of quartz and reduce it to powder, and submit this to the microscope, and we find it to be translucent and clear, and it polarizes brilliantly. Moreover, the fracture of the quartz is different from that of the flint. These conditions understood, we are now prepared for the problem to be solved, one which belongs to the geologist, if not to the physicist.

* It would be more correct, perhaps, to say that it does not give any prismatic colours.

Our eastern counties have beaches of chalk shingle, and sand, and the cliffs are mainly a tertiary deposit, consisting of clays, sands, and flint gravel. These counties are devoid of building stone, so all their ancient churches are built of flint, and much ingenious workmanship is therein shown. Little stone is seen but that which belongs to the upper greensand, locally known as "clunch," sometimes oolite in small quantities, which must have been brought round by sea, and occasionally sandstone, which, belonging to the Wealden system, could not have been obtained nearer than Hastings. Consequently there is no material whatever on the coast capable of furnishing any quartz sand. Still one must always remember that the operations of nature are large, and our views of them small. The visitor to Yarmouth must remark the deep sand deposits on its shore. Let us cross to the other side of the German Ocean, and large dunes or hills of sand are found all around the coasts of Belgium, leading into France as far as Boulogne. Does it come from chalk flint?

I have examined sand from Lowestoft, and I find it all to be of quartz; in a slide made from its sand only one piece of chalk flint is seen. Dr. Matthews gave me some sand from Aberdovey, Wales; it is mostly of quartz, with some intrusions of other substances, but none, of course, of chalk flint. Indeed, no one could discover any difference between the two, although one is on the eastern side of our island, amid nothing but chalk débris, whilst the other is on the western side, in the Irish Channel, where no chalk or chalk flint exists at all. Let us travel higher up our eastern coasts as far as Yorkshire, and at Bridlington the sand is again quartz; in a slide made of it the few intrusions of flint are about three or four.

Let us now come back to our southern coast, and one of the facts that first attracted me in relation to this subject was that organisms using sand for *building* purposes always choose quartz. It is so with that curious sponge *Dysidea fragilis*; it is so also with the ovisacs of one of the mollusca, which at first look so much like a sponge. These are completely built up of quartz sand, and although other fragments are sometimes used, and even foraminifera, yet it is rare to find anything of chalk flint. *Dysidea* is common at Brighton, where the shingle is of chalk flint, and one might think sand also; but it is quartz that is used.

What then becomes of the flint sand? We see the rounded pebbles: abrasion must produce powder, *i.e.*, sand. What then can

become of it? Does the flint change to quartz? Is it possible that any molecular metamorphosis can take place, or, if not, what becomes of the abraded dust of chalk shingle that it is always found in such small quantities? Then whence proceeds this very abundant and ubiquitous quartz sand? The set of the current of the English Channel is, I believe, from west to east; that of the German Ocean from north to south.

We must think of all the conditions existing to account for the prevalence of quartzose sand. On our southern coast there is a large gap between the chalk cliffs of Dover and that of Beachy Head, in which the Wealden deposits make their appearance, consisting of sandstone grit, shaley laminated sand rock, and the like—all of fluviatile origin—remains of the delta of a mighty river, equal, at least, to that of the Ganges. This sand is of pure quartz, or nearly so, and as the Wealden outcrop crosses the English Channel, though not represented on the opposite shore, here is necessarily an abundant supply of quartzose sand. Still we must note that the coasts, all along this gap, have the usual beach of chalk flint shingle. Indeed, it is represented in enormous quantities, often a mile and more in diameter at the closed-up ancient estuaries referred to. First, there is that of Pevensey, where the old Roman castrum is in a more complete condition than is found elsewhere, and which once defended its entry against our ancestors the Saxon pirates. Let us be proud of our Saxon forefathers, of whom the Roman historian pitifully says, "Præ ceteris hostibus Saxones timentur."* Then let us go to Romney Marsh, where is the same phenomenon on a grand scale, and another ancient estuary closed up, the "Portus Lemanis," its fortress, which once defended it, a shapeless, disrupted ruin. Here the rolled shingle covers many a square mile. Where then is the detritus of all this mass, if it is not found in the sands adjacent?

There is still to be brought into the account the upper and lower greensand, the Shanklin sand which must furnish a part of the ocean bed as it crops up by Folkestone at Copt Point. But we have to consider whence these are derived. The more we seem to go into the matter the more intricate or extended does the problem appear; and yet its solution ought to be within a small circle, for what we are seeking to know is, what becomes of the detritus of chalk flint?

* Ammianus Marcellinus.

Let us now proceed to examine the geological deposits of the tertiary period, formed within the large depression scooped out of the chalk, called the London basin. And we will take them in order, and first the brownish loam or brick earth, which is abundant about and in London. Washing a portion of this, taken from the neighbourhood of Hampstead, after getting rid of extraneous matter, there remains a portion of sand, which appears to be in part or wholly of quartz, though much comminuted. Amongst it, however, are some, though few, intrusions of chalk flint. The main fact is the general quartzose character of the whole.

Next in order comes our familiar gravel, with its sand layers of that deep ferruginous hue, prized for our garden walks. Of this I took samples from a section on Epping Forest, near Loughton, made for a supply of fine gravel. Here, one would have thought, if anywhere, being in the midst of a chalk flint débris, rolled together to all sizes, that a vein of sand must show the same form of silex. My specimen was taken four feet from the capping of loam, firmly compacted together, and of a deep rusty colour. On submitting a slide made from this to the microscope by polarized light, I was astonished to find it so uncompromisingly of quartz. There were other substances, yet extremely few in number, and I am not able to pronounce upon them, but not the smallest atom of our familiar flint of which every pebble around was composed. But not satisfied with one specimen of the sand, I took another from a vein of a pale grey tint close by, and the same results ensued, as indeed one might have expected, only in such investigations one should never assume anything, but resort to experiment.

We now come to the series of the Bagshot sands, to which I have alluded, and testing a specimen from Hampstead Heath, after washing it, quartz is found to be the largest basis of the deposit. Other particles, however, are seen in it, some of which look like amber, and some fragments remind one of the colour of the Cairngorm, yet it requires a mineralogist to pronounce upon them. The character is also special in the presence of dark specks and nearly black bodies, and we must certainly seek in another direction than flint shingle, of which few signs are to be seen, as the factor of the Bagshot sands.

The vast mass of the London clay, that deposit of estuary mud of a tropical sea, has its layers of sand represented at White Cliff and Alum Bays, Isle of Wight, and of these I have examined several

specimens, representing upper, middle, and lower beds, as well as other series, but they all declare the same general facts, quartzose sand, with few intrusions of flint, more or less comminuted. So we will take into consideration the layer styled "Pebble bed," where the flint is rolled into marbles of various sizes, intermingled with and embedded in sand. Here, if anywhere, one would expect to meet with atoms of flint in abundance. But the examination of the fine sand of the bed referred to shows the same result, and it suggests to us that flint abrasion produces very small and thin flakes which easily break up and disappear into very minute parts, but that the harder quartz, never taking the same form of fracture, is a more enduring form of silex. So that the one disappears rapidly, whilst the other continues an almost indefinite time. This is the only way I can account for a phenomenon so apparently singular; but I am open to the conviction of a better solution, if that can be given. The result, then, is remarkable in the all but absent flint particles. These are, indeed, represented, but they are few in number in comparison with those of the quartz. There are other substances than this, but, as before, it is the predominant form, although in the midst of rolled flints. The sand is very fine in character, the particles of quartz very small, resembling those of the brick clay.

The "striped sands" immediately beneath this now require to be examined, and one would beforehand be ready, with the facts before us, to pronounce upon the result as one obvious or logically certain, for quartz appears to be everywhere the staple product in the composition of sand. Of these, so well represented in the Isle of Wight, at Alum Bay, I have got an extensive series through the kindness of Mr. J. Starkie Gardner, F.G.S., than whom no one is better acquainted with the Tertiary System. It may seem to some an absurd reiteration to go on proclaiming the same results through a series so evidently cognate; but this is the only way to exhaust our evidence, and repetition is confirmatory. The series obtained from Alum Bay, which I have examined, are eight in number, and their story is similar to what has been already recorded; but it would take some time to give them that minute examination which would make a scientific record. I have, nevertheless, made an analysis, which will be found at the end of this paper.

We now come to the chalk from whose upper series our vast deposits of flint shingle must have been derived by the extensive

denudation and destruction to which it has been subjected. Belonging, geologically speaking, to this series are two layers entitled "the Upper and Lower Greensand," separated from each other by the Gault Clay. The Upper Greensand is best known to us by the limestone, called familiarly clunch, firestone, hearthstone, used extensively in the Middle Ages as a building stone, the Palace and Abbey of Westminster having been mainly constructed of it from the quarries of Merstham, though passing under the general term of "Ryegate Stone." It was also used for effigies, and for indoor purposes; kept free from damp, it was durable, and preserved a sharp edge in its working. Dissolving the lime from it, the deposit shows us nearly half to be finely comminuted quartz, some few particles of flint equally fine, and a large quantity of silicified casts of many species of foraminifera, and particularly of one very minute in size, which I assume to belong to the Globiogerinæ. Other forms I am not acquainted with, look like portions of very minute encrinites, but I must profess my ignorance; and as the subject has been worked out by Ehrenberg, I suppose it is well understood. I may remark, however, that these silicifications have in composition a remarkable resemblance to that of chalk flint, which would rather support the view of Mr. Hawkins Johnson, that the latter was of organic origin. As a factor of the sand of our coasts, this deposit could play but a small part, and may therefore be dismissed for the consideration of the lower bed.

This bed is known as the "Shanklin" Sand, from its being so well represented in that locality, and has at its base a well-known building stone called "Kentish Rag." Taking some seams of sand found with it for examination, I find one-half to be composed of quartz, the other of dark opaque grains, which I cannot identify. I have examined also other specimens from different beds, but the result is the same.

I will now, in conclusion, take a retrospective glance at the facts presented before you. The one great fact is the predominance of quartz. It is only in the two lower beds, "the Green Sand," that this material is not in excess of every other, and even in them it constitutes one-half, and in neither case does the chalk flint appear but in very small quantities. That it should be almost absent in the gravel composed of flint shingle, and from sand veins found in the very midst of its rolled pebbles, is very surprising. The quartz sand, of the gravel, has larger grains by three or four diame-

ters than in any other locality named, and has many points of interest to study. It is well rounded by attrition, which is not the character seen in many other examples. It seems to be often in a state of apparent decomposition, and is covered by an oxide of iron, which requires to be removed by acid for its more complete examination. In the Bagshot Sands we should scarcely have expected to find chalk flint grains, but they appear in the proportion of 4 to 7 per cent., and in this deposit the quartz has some rounding of the edges, but not giving a character to the whole. Nevertheless it more resembles that of the superficial gravel.

I alluded, at the commencement of my paper, to the sand found at Bridlington, and particularly that at Lowestoft, on account of the comparison instituted between it and that of Aberdovey. But it would be a very imperfect argument, after so many specimens from ancient deposits, not to notice some of those now forming. By the kindness of Mr. Priest, I have been enabled to examine examples of the sands of Cromer and those of Ramsgate. They are composed of fine examples of rounded quartz particles, with chalcedony and a few other substances, some of calcareous origin. That at Cromer is resplendent in its quartz, when beneath the microscope, and is, perhaps, the finest of all my examples, extremely beautiful as an object by polarized light, and, I think, instructive in its illustration could one pursue the question further than at present I propose to do. From Hythe, in Kent, I had some sent up to me from high-water mark, thinking it might there be more free from the engrossing quartz. But no, the result is the same as in the previous cases, but these last examples all declare in the flint particles present, flakes unrounded in opposition to the rounded quartz, that the last is ancient, produced by the attrition, perhaps of ages, whilst the other is modern and recent. This evidence is remarkable, as it declares an important fact in our inquiry, which points to the one as ephemeral, to the other as of an unknown duration, perhaps dating its origin from the primitive rocks.

From Dymchurch, in Romney Marsh, where the flint shingle is seen extending for miles up to the point of Dungeness, and always increasing, the sands reveal the same oft-repeated tale,—quartz, with an almost entire absence of flint particles.

I do not here pretend to show whence proceeds this abundant supply of quartzose sand all around our coasts. It is a matter for further inquiry and investigation, but one must suggest the proba-

bility of it being, in part at least, brought down by rivers. And this will at once lead us to consider whether that noble stream, the Rhine, may not be one of the factors of supply. Descending from the Alps in a strong and powerful current, generally turbid, but particularly so after a season of storms on the breaking up of winter, it has for ages poured forth its waters into the German Ocean. I know nothing more imposing than the scene presented, when looking down from the hills beyond Bonn upon the vast delta before you. It is as level as the sea, and far on the horizon the city of Cologne is detected only by the lofty towers of its cathedral, as if a ship riding on the ocean. Its many mouths must each send forth, mixed with its strong current—for it is not tidal—a mass of sand, represented doubtless by the dunes of Holland and Belgium, which have been planted with Equisetum to tie together its instable substance. The Alpine loess of Belgium is itself largely commingled with quartzose sand of similar origin, making a large source of supply.

Amongst other materials than quartz referred to, chalcedony is the most common ; there is also a kind of conglomerate, of minute parts, which polarize vividly, some fragments homogeneous in colour, being of a neutral grey, as well as some other substance less easy to describe, whilst in some few cases there are pieces evidently from granitic rock. Flint, when seen under polarized light, does not exhibit colour, but nevertheless its character is thus best distinguished. Occasionally I have imagined I have seen some instances in which a change has been undergone. I speak of this doubtfully, but certainly there is nothing which has the slightest approach to a metamorphosis into quartz. It has been supposed by some that an infiltration of chalcedony does take place occasionally, but that must surely be, if at all, before the formation of sand particles. An old French writer, M. Reaumur, in the "Mémoires de l'Acadèmie des Sciences," 1721, writes :—" By a coarse operation emery is reduced to powder, and suspended in water several days ; but nature may go much further than this, for the particles which water detaches from hard stones by simple attrition are of an almost inconceivable degree of fineness. Water thus impregnated contributes to the formation of pebbles by petrifying the stone, as it were a second time. Stones already formed, but having as yet a spongy texture, acquire a flinty hardness by impregnation with this crystalline fluid."

I state this as I find it. The author gives no facts, so the hypo-

thesis must stand by itself. But there is one point worthy of note, wherein he speaks of the extremely minute particles produced by mere attrition. This in rounded pebbles must indeed be infinitesimal, and one could hardly expect to find such particles of any moment in the composition of sand. But it must be otherwise with the rough flint, as it comes from the chalk, and doubtless such sand particles of this material, which are found, are thus produced before the pebble is softened into a rounded form.

It would certainly be plausible, as has been suggested, that a molecular change may take place in flint during the lapse of ages, difference of temperature, and the like. But the fact that flint particles do appear, although in small quantities, in ancient deposits, exactly the same as you may now artificially produce them, deprives us of the use of such an argument. Its great scarcity, as I have shown you, almost seems illogical, but the sternness of our facts makes us accept them whether we like it or not, and we must endeavour to explain this phenomenon by the same logic of facts. But the ubiquity of quartz sand is not confined to our coast. In examining some organisms from South Australia, containing sandy particles, some also from Mauritius, Madagascar, and Algoa Bay, the same facts are shown. There are not only the common quartz grains, but other materials, such as are visible among the sandy deposits I have described, and seen in about the same proportion. This is interesting, as declaring one universal source, whether in the northern or southern hemisphere, and helps in the illustration, if not in the solution of the question before us.

I must confess to ignorance of many points of detail suggested in this inquiry, but as we are composed of many active units, let us take a moral from a grain of sand, one of the smallest of atoms, yet in its aggregate playing so great a part in this earth's crust. Let, then, the aggregation of our Society's units make a large addition to our scientific knowledge; the subject before you has yet many lapses, and I trust these may be filled up by your active researches.

The following is an analysis of the sands of the Tertiary system :—

BEDS OF SAND. TERTIARY SYSTEM.

1. London Clay. Alum Bay.
2. Top of London Clay. White Cliff Bay.
3. Top of London Clay. Alum Bay.

4. Middle London Clay. White Cliff Bay.
5. Middle London Clay. Alum Bay.
6. Base of Bournemouth Series. Alum Bay.
7. Base of Bournemouth Series. Alum Bay.
8. Bournemouth Beds. White Cliff Bay.
9. White Cliff Bay.
10. Studland Beds. Alum Bay.
11. Hengistbury.
12. Hengistbury. White Sand.
13. High Cliff.
14. Cruch Barrow.
15. Cruch Barrow.
16. Lower Boscombe Beds. White Sand.
17. Thanet Sands. Alum Bay.
18. Upper Bagshot. Hendon Hill.

Examined by polarized light give the following results:—

1. Quartz, grains medium size, clean, few flint grains.

2. Quartz, grains generally small, a few larger, no rounding, flint grains few.

3. Quartz, grains clean, medium size, some conglomerate of fine particles, few flint grains.

4. Quartz, grains small, irregular in shape, some opaque grains, flint grains few and small.

5. Quartz, grains generally small, intermingled with a few larger, all ragged in outline.

6. Quartz, grains small, minute particles, brilliant under polarized light, very few and small grains of chalk flint, edges ragged.

7. No material difference, but less of minute particles.

8. Very similar in character to 6 and 7.

9. Quartz, clean, medium size, few flint grains, no rounding.

10. Quartz, grains large, ragged edges, mixed with smaller grains, red colour due to an oxide of iron.

11. Quartz, grains large, rounded, brown grains caused by a cementing of smaller ones together with a substance of that colour, a few flint grains.

12. Quartz, grains large, not rounded, few and small flint grains.

13. Quartz, grains not rounded, of medium size, some cemented together by a dark substance, few flint grains.

14. Quartz, grains large, apparently once rounded by attrition and afterwards broken by crushing? some grains conglomerate of small particles.

15. Quartz, grains large, some much rounded, as above (14).

16. Quartz, grains generally large, some rounded, others irregular in outline, and then smaller, some conglomerate of fine particles, very few flint flakes.

17. Quartz, grains variable in size, but generally small, very fine particles, also few flint grains.

18. Quartz, grains variable in size, but generally small, like 6 and 7.

To understand the above analysis it would be well to see what the result is in modern accumulations. Generally, it will be found, that the larger grains of rounded quartz are the products of the sea-shore. The smaller ragged characters are not so easy to account for; they resemble what is produced by crushing with a hammer. This is exactly how it appears in the " Pebble Bed," that hard closely compressed mass of shingle which lies beneath the London Clay. It may be, however, that these deposits of finer sand are a sifting of smaller particles by a gentler action of water, which, leaving heavier parts behind, carries off the lighter. There are, certainly here some interesting questions for the geologist to determine, and I have left much to be studied in the question of " Sand."

On the Histological Development of the Larva of Corethra plumicornis.

By T. Charters White, M.R.C.S., L.D.S., &c., &c. (President).

(Read Feb. 24, 1882.)

Plate II.

For investigating any of the mysteries of biological science the student is generally recommended to avail himself of those simple demonstrations of life which nature so abundantly supplies to all who seek for them. Examples present themselves on every hand, but in no case so ready to our use as in aquatic life, whether animal or vegetable, and by carefully studying them we are enabled to watch and record operations in many respects similar to those taking place in that mysterious laboratory which every man carries about with him in his own body, and which in their totality make up the sum of his daily life. This recommendation was brought home to my mind with much force while examining the changes taking place in a larva of *Corethra plumicornis*, which, being kept under observation on the stage of my microscope, enabled me to watch the gradual development of its various tissues and organs. The interest felt in this observation would have been intensified had I been able to have watched its development from the egg, but in the present case its internal organs were in a tolerably advanced state of growth, sufficient of its development, however, being wanting to furnish much interesting work for observation and to supply me with notes for a short communication this evening, leaving the earlier stages of this creature's development to be worked out by those fortunate enough to procure its eggs, when it would be interesting to bring its life-history up to that stage in which it usually appears before us, and in which it was presented to me.

The external form of this creature is so well known to all microscopists that I need not occupy your time and attention by any lengthened description of it, but it may aid our subsequent examination if we note that its body is divided into eleven segments, the head being the first, the thorax the second, followed by nine abdo-

minal segments, the first being furnished with an elaborate plume of branched hairs, four finger-shaped processes, and a set of rather formidable-looking serrated hooks. We all know its beautiful transparency, from which it is sometimes called the "*Glass larva.*" It is this transparency which renders it such a convenient subject for observation, although the superposition of many of the internal organs creates a difficulty in tracing out the developmental changes which only patience and a change of position in the larva can overcome. In striving to know as much about this creature's internal anatomy as possible, we might be tempted to seek such extraneous aids as can be furnished by staining fluids; and here let me relate my experience. *Corethra plumicornis* will live in carmine solution for several days, but not take the stain in the slightest degree; osmic acid of $\frac{1}{2}$ per cent. strength does not seem to affect it injuriously; even acetic acid largely diluted with water does not seem to act prejudicially to an existence extending over some hours; but if the internal organs are dissected out and put into staining fluids, they take the colour readily. I must therefore content myself by giving you the best description I am able to do at present, hoping that by the patient investigations of others better methods of observing the histological changes of this larva may be devised.

The particular larva of *Corethra* which I made the subject of these observations was, when first presented to my notice, in a condition slightly less developed than that commonly met with. Diaphanous as glass, with very little differentiation of its internal tissues, its muscles were visible as structureless bands of jelly endowed with feeble contractility. The pulsations of its dorsal vessel took place with dull and broken rhythm; its alimentary canal had but faint markings on it, scarcely pointing to its future glandular character; its brain was just indicated by a crude gelatinous mass situated in a sinus posterior to the eyes, while the central ganglionic chain was only rudely mapped out by scarcely distinguishable fibres. The viscera were held in place by suspensory ligaments, which stretched from them to the internal sides of the body cavity. The circulatory system contained nothing of the nature of a blood-corpuscle. Such, then, is a rough description of its almost rudimentary condition at the period I commenced my observation. Day by day, however, showed an alteration in the tissues, and changes might have been noted even in a few hours, but when they occurred

or how they took place it is not possible to state, so gradual was the process. The larva under observation, and which upon several occasions I had the pleasure of submitting to your notice, monopolised the stage of my microscope for one month, when it died, but you may see by looking at others collected at the same time as this the changes which have been produced in that time. From the rudimentary condition I have described it has passed into a stage wherein its internal anatomy is considerably advanced, and it is preparing by other interstitial changes for assuming its pupal existence. I cannot give you the definite times at which these changes took place, but can only note them somewhat in the order in which they occurred, taking first the various segments and their special contents, and then those parts which are common to the whole body. The first segment or head, with its pairs of formidable jaws, naturally claims our primary attention. Professor Ray Lankester, at the time his father occupied this presidential chair in 1865, wrote a short but accurate account of the anatomy of this larva, which was published in the "Popular Science Review" for that year, and which I should recommend to your notice. In this article he divides these jaws thus :—The first of these pairs he terms *Tarsognaths*, or oar-like appendages ; each consists of two parts, a stem and four long terminal bristles. The next pair are termed *Trichognaths*, or labial bristles. The third pair are very curiously serrated, and called *Pristognaths*, or saw-like organs. Then next in order, counting from the end of the beak, comes a central prehensile organ. It is a projecting, cylindrical body, capable of being moved backwards and forwards, having its top crowned by two groups of hairs. This is called the *Mesognath*. This can be used either as a finger and thumb by the apposition of the two lips carrying the respective groups of hairs with which it is crowned, or it can be used as a broom to sweep prey into its mouth. When bent forward it falls easily and naturally between the two jaws, which are placed next in order, and called *Platygnaths*, very powerfully constructed, and capable of crushing the unfortunate victim who once gets entangled in their grip. All these organs are furnished with strong muscles, and these were, as you will suppose, more developed than those supplying the rest of the body, and not so important to the creature's subsistence, for as *Corethra*, as we will call this larva for brevity's sake, is reckoned a very predacious and voracious subject, and as development presupposes and requires food to keep it up, so here

we find in the set of jaws and the early development of their muscles the means by which its food can be obtained ; but even in these muscles very little striation was evident. It required careful focussing and an accurate amount of light to make out any structure in the muscular system of the first segment. The brain at this early stage showed no structure, but soon minute granules made their appearance, these granules ultimately becoming cells, the outer part of the brain being characterised by cells of a larger size than those occupying the deeper and inner parts. At the same time its colour deepened to a greenish yellow tint, and exceedingly fine ramifications of tracheal tubes coursed through its substance. From whence these tubes acquired their supply of air I could not discern. There did not appear to be any connection with the air vesicles in the next segment at this stage, although there is later on. The brain is formed by the union of two ganglia, which give off processes to supply the eyes. It is covered by a membrane, in which may be seen large projecting nuclei. It is contained in a cavity, and held in suspension by ligaments, which allow a certain amount of movement, and is bathed at every pulsation of the dorsal vessel by the circulatory fluid. Two nerve-cords, being the continuations of ganglia forming the brain, divide in their passage from the dorsal aspect of the body to the ventral, and embracing the pharynx, unite below it to form the sub-œsophageal ganglion, the first of the chain to which I shall presently call your attention. The next points of attraction in this segment are the eyes, which arrest attention by their size and blackness. They are situated one on either side of the head, and appear as oval black patches encircled by clear, brilliant lenses. It is not easy to see that the entire surface of the eye is covered with similar lenses, and without careful opaque illumination they are liable to be overlooked. I have not been able to detect anything like an expansion of the optic nerve to form the retina, but from analogous instances in the insect world it may exist in this case, although not easily seen. Situated near them are two smaller black spots. These have occasionally one or two lenses, similar to those in the larger eyes, irregularly placed at the edge of the black, and it was only surmised that these might be considered rudimentary eyes, especially as no connection apparently existed between them and the brain, but by placing the larva in a shallow trough which allowed it to turn, I was enabled to see under a $\frac{1}{3}$ of an inch power that a small branch of the optic nerve is in con-

nection with this eye, proving conclusively the true nature of this ocellus (fig. 1). In this first segment we may also notice a portion of the pharynx. This is very wide, and opens as a trumpet-shaped mouth between the two *Platygnaths*. In its earlier stages it appeared almost destitute of structure, saving for the presence of minute longitudinal striæ, but as development advanced it was seen to consist of two coats, an internal one comparatively devoid of structure, but armed with a number of minute chitinous teeth, and an external coat composed of longitudinal and annular muscles. These two coats are attached loosely to each other by very fine and scarcely visible fibres of connective tissue. This creature has a curious power of everting the whole of the pharynx together with the gizzard and œsophagus when irritated, and this proceeding does not appear abnormal or productive of inconvenience, but rather, if we may judge by the presence of two partially coiled nerves which accompany the œsophagus in this eversion, it would seem as if an intentional provision had been made for this performance, the animal swimming about for days with its pharynx projecting from its mouth.

Passing now from a description of the head, we will examine the second segment, or thorax, and its contents. The most prominent objects which first arrest the attention are two dark reniform bodies, which occupy the centre. These are air-vesicles. They consist of a delicate membrane distended by air, and having their coats strengthened by chitinous rings similar to those met with in the tracheal tubes of the Insecta. The outer surfaces of these sacs are partially covered by patches of some dark brown material possessing one or more nuclei, but of whose nature and purpose I cannot offer any explanation except that later on in this creature's development these patches appear broken up ; at the same time large globules of some highly refractive substance appear in their vicinity. In the earlier stages these air-vesicles appear to have no communication with other parts of the body, nor with each other, nor with two similar air-sacs situated in the ninth abdominal segment, but later on each vesicle undergoes a slight elongation of one of its ends, forming a short tube having a bulb at its extremity, from which ultimately a number of fine tracheal tubes are distributed throughout the adjacent tissues. Near these air-sacs are seen the salivary glands. These are two elongated tubular bags with sacculated walls containing large nuclei. The necks of these bags are prolonged

into tubes, which unite to form a common duct, opening on the floor of the pharynx just inside the mouth, but not easily demonstrated, owing to the superposition of various muscles and ganglia. On the external surface of the *Corethra* some very delicate fan-shaped tufts of hair may be seen, and from a careful examination of them and their connection with the muscular and nervous systems we may reasonably conclude that they serve as organs of touch. They are situated in pairs, four on each segment of the body. Those on the thorax are abundantly supplied with nerve-fibres of a larger size than are given off to the other segments. The nerves pass off from the large ganglia and enter ganglia at the bases of the hairs. These ganglia are of a different character, being furnished with a striated, cortex and a granular centre, and seem specialised organs, of whose office I do not feel justified in speaking positively, but they form most interesting objects of investigation when examined in profile, for then we are enabled to make out the connection which exists between the base of the hairs and the ganglion of the ventral chain (fig. 2). Those situated on the other segments are more simple in their character. They are attached to the integument by their bases being inserted in a cup-like depression. On looking through the transparent walls of the body, the root of each hair will be seen in connection with a ganglionic body, from which we can trace a nerve-fibre giving off branches to the muscles over which it passes, and becoming merged in the central ganglion of that segment (fig. 2). The office of these hairs seems to be that of warning the larva of the proximity of danger, the contact against these hairs conveying the irritation to the central ganglia, when a reflex action is set up in the muscles, causing them to contract, and producing those jerking movements by which *Corethra* manages to evade any obstruction which may intrude in its path. Passing over the intervening segments, which contain nothing specially to be noticed, we come to the eighth, in which we observe two elongated bodies filled with ovoid cells. In the earliest conditions of this creature's existence these are clear spindle-shaped sacs filled with a structureless protoplasm, but having a small collection of granules in their central axis. After a time these granules become distinguishable as cells, filling the whole interior ; later still these spherical cells become egg-shaped, while the fusiform sac becomes elongated and tubular, and in them we recognise the characteristic ovisacs of the Insecta. Now, having called your attention to the special

organs met with in an examination proceeding from the head to the tail, I will say a few words on those organs which extend through all the segments.

The nervous system first demands our consideration as the mainspring of this wonderful and interesting life. Taking their rise in the two united ganglia which form the brain, two cords of nervous matter passing from the dorsal aspect to the ventral, divide to embrace the pharynx, and uniting below form the sub-œsophageal ganglion, the first of a chain of ganglia which terminates in the ninth segment. In its earliest stage this ventral chain, like the brain, was structureless and gelatinous in its character, whilst its ganglia were indicated by rude unshaped swellings. The connecting cords could scarcely be described as fibrous, but soon the borders of all became more defined, and nervous fibrillæ could be seen distributed to the muscles and organs in their neighbourhood. It is about this time that the muscles begin to show an opalescence when viewed with a spot lens, and I call your attention to this fact because of the interesting connection existing between the completion of the nervous system and the commencement of histological organization; under a moderately high power and careful illumination this opalescence can be resolved into fine but irregular striation of the muscular fasciculus, the striæ not marshalled into the regular order characteristic of the muscular fibre later on, but scattered about in "admired disorder." Entering the sarcolemma of the muscle together with the nerves, are delicate branches of the tracheal system; the growth of these tubes would form a most interesting subject for future study. In the early stages of development, the viscera of this larva are held in position by apparently structureless ligaments which connect the viscera with the interior of the body cavity; in the later stages these ligaments are perforated in their interior by the growing tracheal tubes, which, terminating in exceedingly fine ends, may nevertheless be seen by daily observation to be pushing their way onwards, and giving off similar branches to adjacent organs, and so furthering their development, because the nervous system may furnish life, but the respiratory function must support it, and so the two functions take place almost side by side, the nervous system getting rather the start. The muscular system may be divided into three groups, those which supply the jaws, those confined to each segment, and a longer set which pass through several segments; they are contained in fibrous sheaths of sarcolemma, having large nuclei projecting

from the surface. No longitudinal fibrillation seems to take place in them till a very late stage of their growth, when it occurs by a splitting up of the bundles at the points of their attachment, and then the bundle or band becomes a fasciculus of fibres, but long prior to this stage the interesting phenomena of their behaviour under polarized light may be observed, the entire muscle being thrown into contraction by disturbing the larva, transverse bands of colour appear which vary with the intensity of the contraction. The sarcolemma is thrown into corrugations by the contraction, each corrugation showing on one side a colour and on the other side its complimentary tint, and as the contraction ceases, and these corrugations subside, the colours fade and gradually pass away, reminding one of the coruscations of an aurora. Upon treating the larva to a very dilute mixture of spirit, acetic acid, and glycerine, the muscles threw off waves of contraction which, passing down the course of the fasciculus, could be readily watched, the node of contraction showing a fibrous appearance rather than a striated.

The union of the nerves with the muscles is shown in a most instructive manner in this larva; the Doyèrian eminences are triangular processes of nerve matter, through which the nerve becomes fused with and pierces the sarcolemma of the muscle. Several of these eminences can be seen either in profile or as plates, according to the position in which the larva may place itself.

The dorsal vessel or heart forms another interesting subject of observation, and will attract the attention of all who examine *Corethra* by its regular pulsation, as well as by the incessant movement of those pale brown bodies attached to its walls. While voluntary muscles are at rest, those organs immediately subservient to life must perform their offices independently of volition, and the animal heart, whether it be of the vertebrate or invertebrate type, must keep up the constant current of the circulating fluid. It may differ in shape between the two classes, but its office is the same, and it is under the same nervous influence, viz., that of the sympathetic system. The ventral chain does not give off any fibres to supply this dorsal vessel; therefore these incessant pulsations, averaging from 12 to 19 per minute, are automatically governed by the pale brown granular bodies attached to its walls. These bodies are of various shades of brown, and carry one or more large nuclei, increasing by self-division. They are exactly of the character of the sympathetic nerve-cells figured in "Stricker's Histology," p. 176. The dorsal

vessel commences in the tenth segment, and terminates in what we might call the neck of the larva; it is composed of two coats of great tenuity, the internal lining having delicate longitudinal muscles, and the external coat composed of circular fibres, but it is so diaphanous that it is only by very careful manipulation of the light that these details can be made out. It seems to float freely in the body cavity, being held in suspension by very fine muscles which, like guy-ropes, attach its walls, allow of free movement, and become merged in the sheath of the sympathetic ganglion. In the ninth segment these muscles form quite a fan-shaped leash of threads. At its commencement in the tenth segment, it has an opening guarded by a large valve, and at its termination in the thorax is another opening, round which a band of circular muscular fibres acting like a sphincter are placed. There are about eight valves in the abdominal segments, but none in the thorax, but the coats of the vessels in this portion are more muscular, and it seems to have the power of contracting longitudinally to such a degree as to close itself almost entirely ; it does not seem to act so rhythmically as the abdominal portion. There are several valves in the abdominal portion, but on account of the free movement of the vessel, the focal plane is being constantly shifted, rendering it a matter of considerable difficulty in using a high power to see the details of their mechanism, but it appears to me that their shape may be compared to a truncated cone, opening inwards into the vessel, and closed by the sudden collapse of its two sides. That openings through these valves do exist, I have proved by seeing blood corpuscles drawn through them in the act of expansion. The blood, which is very sparingly supplied with corpuscles, can be detected slowly moving through hollow spaces between the viscera, and it consequently bathes the external surfaces of them till being drawn by the expansions into the dorsal vessel, it is impelled towards the head, when it again slowly descends through these cavities, and the process is repeated ; thus you see the circulation is of the simplest description.

The alimentary system, commencing as we have seen in the first segment by the mouth and dilated pharynx, is continued about as far as the junction of the thorax and first abdominal segment, where the pharynx terminates in a gizzard ; this gizzard is formed externally by several rings of powerful muscles, while the interior is furnished with a membrane having a close array of chitinous ribs and two

curved teeth. Passing through this organ, we see an extremely narrow œsophagus, which extends through the third segment. It is composed of longitudinal muscles, and accompanied on either side by a slender nerve. This œsophagus passes into a wide extremity of the stomach. The stomach extends from the third segment, tapering gradually to the ninth segment, when it is slightly enlarged, and four cæcal tubes are given off from it, two going as far as the eleventh segment and two stopping short in the tenth. I cannot speak positively of the office of these tubes, but I think they may be biliary tubes, as sometimes when the larva is well fed they are filled with a yellow secretion; they have thick nucleated walls, with granular structure. Passing from the juncture of these tubes, the alimentary canal again becomes suddenly narrowed to a tube but little wider than the œsophagus, and then as suddenly becomes dilated to form what would be a rectal pouch, showing, however, no evidence of rectal papillæ; the alimentary canal then tapers off again and ends in an opening in the centre of the four finger-shaped processes which help to form the tail. It is a very rare thing to find anything approaching to the nature of solid food in this canal, and in one larva which I examined we may find the explanation for this—its pharynx was widely distended with small daphniæ and cyprides, and the stomach was in active peristaltis, when after a time it vomited the shells, and a violent jerk of the body scattered the evidences of its meal.

But now, approaching condensation of the integument partially obscures the sight of the wondrous changes taking place within; even this obstacle to further observation is attended by much interest, for we notice amœboid corpuscles in active movement, gathering together in groups in the endothelial lining of the outer shell of the larva, and especially in the neighbourhood of the union between the segments, and uniting by their borders form hexagonal or polygonal cells, in which may often be seen brown particles which may ultimately furnish the chitinous tissue of the future pupa. It is this subsequent obscuration which will bar our progress in watching the further developmental changes, and it is to be regretted, inasmuch as it would be of great interest to see from which tissues the wings are formed. We can only hope that when this larva undergoes its first moult and passes into the pupa, the integument may be sufficiently transparent to enable us to record further development. Gentlemen, I hope I am not wrong in presuming that what

has been to me a subject of much interesting observation during the last two months will be also to you a source of much pleasure and instruction. I have endeavoured in this paper to be as clear in my description as the necessarily complicated condition of this larva's anatomy would permit. I have left a great deal more to be worked out, and difficult work too. I feel that I have not been erroneous in any of the details I have set before you, and though I may be wrong in the interpretation of the offices I have assigned to the various organs, I think my critics will find it more easy to criticise than to work out a contradiction. I have faithfully described what very good appliances and careful observation permitted me to see, and I leave the subject in your hands, feeling that there never was one in which it was more necessary to remember the injunction of that careful observer Dr. Braxton Hicks, viz., "to follow truth with hesitating steps."

DESCRIPTION OF PLATE II.

Larva of *Corethra plumicornis*

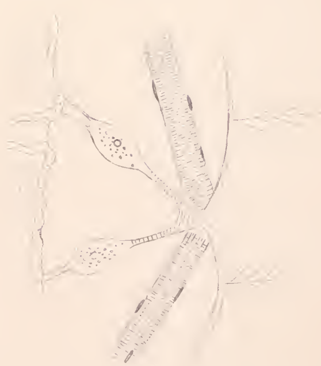
Fig. 1.—Eyes, and their connection with the brain.
Fig. 2.—Branched hairs, and their connection with muscles and ganglion.
Fig. 3.—Progressive stages in development of ovisacs.
Fig. 4.—Sympathetic nerve-cells attached to wall and valve of dorsal vessel.

1

2

3

4



T.C. White del. Mintern Bros. lith.

List of Objects found at the Excursion to Snaresbrook, March 11, 1882.

Communicated by Mr. W. G. Cocks.

(*Read March* 24, 1882.)

Bursaria truncatella (a singular and somewhat rare organism), abundant in one pond only.

Æcistes umbella, scarce.

Melicerta pilula, abundant on *Sphagnum*.

Noteus quardricornis.

Anurœa curvicornis, plentiful.

Monocerea ruttus and other loricated rotifers.

Conochilus volvox, abundant and very fine.

Stephanoceros Eichornii, very large.

Melicerta ringeus.

Epistylis grandis.

Actinophrys Eichornii.

Actinophrys viridis.

Amœba, very fine.

Dinobryon sertularia.

Difflugia proteiformis, very fine and active.

Floscularia ornata.

Micrasterias rotata.

Clasterium, various.

Volvox globator, abundant, and in fine condition.

Nitella, fine and abundant.

Stauricarpus gracilis, a very beautiful chain form.

LIST OF EXCURSIONS, 1882.

The following are the arrangements for the current season:—

March 11. Snaresbrook. Returning from George Lane Station. To meet at Liverpool Street and Fenchurch Street Stations.

March 25. Highgate Station, for Alexandra Palace. To meet at Moorgate Street and King's Cross Stations.

April 8. East End, for Finchley. To meet at Broad Street Station.

April 22. Caterham, for Godstone. To meet at Cannon Street Station.

May 6. Esher. To meet at Waterloo, Suburban Station.

May 20. Totteridge. Returning by Mill Hill. To meet at Moorgate Street Station.

June 3. Chingford. To meet at Liverpool Street Station.

June 10. Excursionists' Annual Dinner.

June 17. Hampton Court. To meet at Waterloo, Suburban Station.

July 1. Shepperton, for Walton. To meet at Waterloo, Loop Line Station.

July 15. Weybridge. To meet at Waterloo, Main Line Station.

July 29. Day Excursion, Whitstable. To meet at Holborn Viaduct Station, 10 a.m., or next later Train.

August 5. Homerton, for Hackney Marshes. To meet at Homerton Station.

August 19. Northfleet, for Swanscombe. To meet at Cannon Street Station.

September 9. Taplow. To meet at Paddington Station.

September 23. Bromley, for Keston. To meet at Holborn Viaduct Station.

October 7. Barnes. To meet at Waterloo, Loop Line Station.

The time of departure from Town, unless otherwise specified, will be the First Train after Two o'clock.

W. G. Cocks,	W. W. Reeves,	Excursion Committee.
E. Dadswell,	T. Rogers,	
F. W. Gay,	J. Spencer,	
F. Oxley,		

On Fishes' Tails.

By E. T. Newton, F.G.S.*

Read March 24, 1882.

Plate III.

Part I.

DESCRIPTION OF THE TAIL OF A YOUNG SPRAT, AND COMPARISON WITH OTHER RECENT FORMS.

Some years ago, when studying the osteology of the common Sprat *(Harenga sprattus)* I was much interested in the structure of the tail, which seemed to me to present peculiarities worthy of a careful investigation. One of the youngest examples which could be obtained was prepared and mounted in glycerine jelly. Drawings of this having been carefully made, it was put on one side in the hope of obtaining still younger specimens, so that, if possible, its development might be worked out, and compared with the various early stages of the *Gasterosteus*, the development of which had been so ably investigated by Prof. Huxley.† Unfortunately I have not been able to get any smaller and younger specimens; but it seemed to me that possibly the description of this preparation, and its comparison with other forms, might be sufficiently interesting to justify my bringing it before the Club.

Before commencing this description it will be well just to say a few words on the forms of fishes' tails generally, for the terms which have been used with regard to them do not appear to be clearly apprehended by many persons.

In so far as the external form of fishes' tails are concerned they present two main types, namely,—those in which the fleshy portion of the body is continued upwards to a greater or less extent

* At a time when microscopical subjects are so freely admitted to the publications of other than microscopical societies, no apology is necessary for bringing before the Quekett Club a paper like the present, which, although treating of macroscopic matters, is founded upon microscopic work.

† "Quart. Journ. Micro. Sci." vol., VII., p. 33, 1859.

into the upper lobe of the tail; while the lower lobe has no such extension of the body into it, is often much smaller than the upper part, and looks like a fin placed under the tail. This is termed a *heterocercal* tail, and occurs in most sharks, in the sturgeon, and in other forms. In the second form the upper and lower halves are alike, and the fleshy termination of the body is as much below as above the middle line. Such tails are called *homocercal,* and are found in the ordinary bony fishes, such as salmon, cod, sprat, &c.

Judging from *external* form alone, therefore, fishes' tails are either *homocercal* or *heterocercal;* but when we come to examine the foundations on which these tails are supported, that is their skeletal structures, they are found to present differences which render it necessary to modify these terms. The tail of a shark, such as a dog-fish, is found to have a series of the vertebræ running upwards into the upper lobe and occupying the middle of the fleshy part, while by far the larger portion of the tail-fin is placed below the end of the vertebral column. The internal structure, therefore, in this case agrees with the external, and the term heterocercal is strictly applicable to it. The *Lepidosteus,* or bony pike, of N. America, has the tail more nearly equal, but still the fleshy portion of the body is seen to be directed upwards, and the vertebral column is found to be directed upwards also (Pl. III, fig. 4.) So that this tail is really heterocercal, though apparently much less so than the shark's.

If, now, we take one of the ordinary homocercal fishes, we shall find a very different structure. The stickleback has an externally homocercal tail, the fleshy body terminating in an equally rounded end, on which the fin rays are symmetrically disposed. Internally the vertebral column seems to end in the middle of the tail, fig. 2, and to have attached to it two broad triangular plates, on which the fin-rays are so disposed as to form a tail *apparently* as much above as below the end of the spinal column. But this appearance is delusive. It had long been known that in the salmon embryo the tail became turned upwards as in the heterocercal fishes, but it was supposed to become equal in the adult. Prof. Huxley, in 1859 (*loc. cit.*), worked out the development of the stickleback's tail, and has shown us that the apparent homocercality of the adult is a secondary development, and that the tail is really heterocercal. At an early stage the end of the notochord becomes strongly bent upwards, and below it two triangular plates appear, upon which the fin rays are

supported. As ossification proceeds the vertebræ become segmented off, but that part of the notochord which turns upwards becomes gradually enclosed in a bony sheath, and in the adult is seen lying along the upper edge of the uppermost triangular bone, fig. 2, *nch*, so that nearly the whole of the tail is attached to the under side of the termination of the vertebral column. The tail of the stickleback therefore, although externally *homocercal*, is internally extremely *heterocercal.*

There is yet one other kind of fish tail to which attention must be drawn—it is that which has both the external form and the internal structure arranged symmetrically with regard to the end of the vertebral column. The *Ceratodus* of Australia has a tail of this description. The notochord in this fish is never ossified, but passing directly backwards, ends in the middle of the tail, and the fin rays are arranged as much above as below it.

When it became known that some of the externally homocercal tails were really extremely heterocercal, it became necessary to make some distinction between those which were really homocercal and those which were only apparently so. Now as the term homocercal has always been applied to those forms, chiefly Teleosteans, which were externally equal, but had now been shown in many instances not to be so internally, it was decided to retain the name for these, and to call those forms *diphycercal* which were truly equal above and below, internally and externally, as in the *Ceratodus*. And fishes' tails are now generally divided into three groups as follows :—

1st, *Diphycercal.* Those tails in which the vertebral column or notochord passes directly backwards, without turning upwards, and divides the tail into equal upper and lower portions.

2nd, *Heterocercal.* Those which externally are seen to have the end of the body turned upwards, and to a greater or less extent passing into the upper part of the tail, and internally have the vertebral column or notochord passing upwards in the same manner.

3rd, *Homocercal.* Those which externally appear to be as much above as below the middle line of the body, but internally show the end of the vertebral column turned upwards, and the larger part of the tail placed below it.

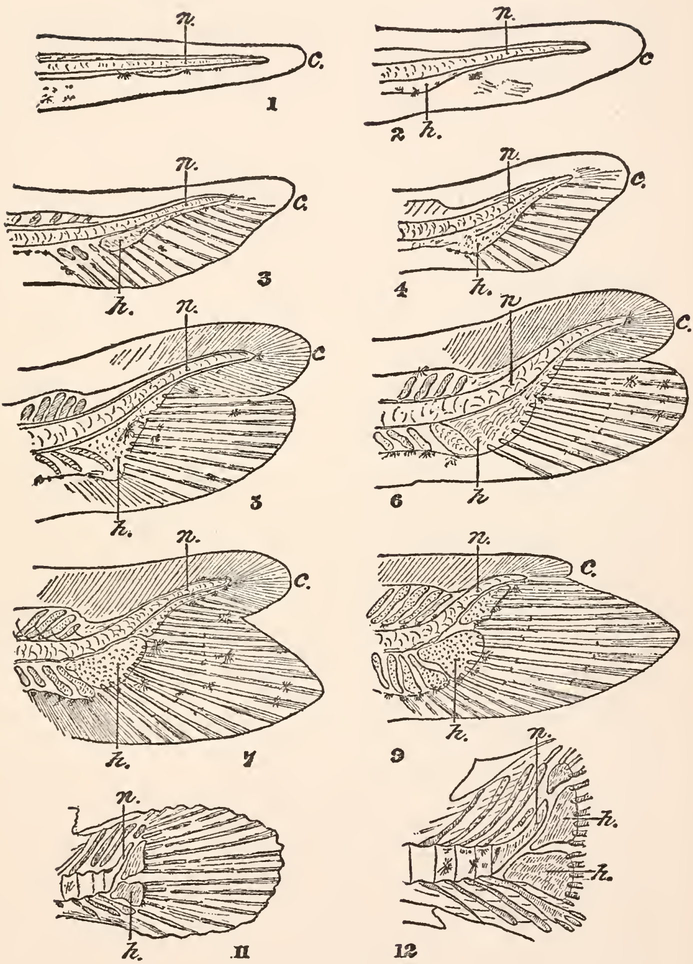
There is another matter to which I must call attention before proceeding to describe the sprat's tail. The development of the flounder *(Pleuronectes)* has been worked out by Prof. Alex. Agassiz,* and

* "Proc. Am. Acad. Sci.," vol. XIII., p. 117.

this enables us to approach the subject in a much more satisfactory manner.

Prof. A. Agassiz traces the development through 12 stages (*vide* p. 83), and according to his observations—1. A flounder (*Pleuronectes*) just hatched has the notochord extending into the middle of the tail, which is nearly equal above and below. This is the condition which Prof. A. Agassiz calls the Leptocardial stage. 2. Shortly after the end of the notochord is seen to make a bend upwards, becoming slightly arched below. The very slightest trace of a division is seen in the edge of the fin towards the extremity, and this increases in the next stages. 3. Two plates of tissue are to be seen below the notochord. The division between the embryonic and permanent caudal fins becomes more distinct, and fin rays are to be seen. 4. All the last-mentioned points become more distinct, and the tail is distinctly bilobed. 5—9. The permanent tail becomes larger in proportion to the embryonic caudal lobe, so that the former soon equals and then surpasses the latter in size, and in stage 9 the embryonic caudal is only seen as a little lobe on the top of the permanent caudal. Internally the structures are essentially as in stage 4, but have become more marked. 10. The last stage before ossification ; the embryo caudal is almost gone ; the broad plates of cartilage have assumed more of the form we have been familiar with in the *Gasterosteus*. In stages 11 and 12 ossification has set in, and the vertebral column has become divided into its component vertebræ, and eventually the upturned end of the notochord is encased in the urostyle, as in the *Gasterosteus*.

The specimen of a young sprat's tail represented in Plate III, fig. 1, includes the last four vertebræ of the column with the representatives of those which are turned upwards and the hypural appendages ; but in the drawing all the fin-rays are omitted so as to render the remaining parts more distinct. The figure is enlarged about 25 times. It will be noticed that these four vertebræ decrease in size a little, but only a little, as we trace them backwards. They each bear well-developed, neural and hæmal arches ; but while the upper arches are about equally developed, the last two lower ones are enlarged and flattened at their extremities. The fifth vertebra is much modified, and commences the upward turn of the vertebral column, which, behind this point, is directed upwards at a considerable angle. Behind the fifth vertebra three or four ossified segments are to be traced. The first of these (sixth from front) seems to form a definite vertebral cen-



VARIOUS STAGES IN THE DEVELOPMENT OF THE TAIL OF THE FLOUNDER. After Prof. Alex. Agissiz.—*n*, Notochord; in Figs. 11 and 12 this is ossified to form the Urostyle; *c*, Embryonic Caudal fin; *h*, Hypural plates.

trum, but beyond this it is not quite certain whether the segmentation includes the bony parts as well as the notochord. The neural arch of the fifth vertebra is broad, but not nearly so long as the one preceding it (*na**). The hæmal arch of the fifth vertebra is peculiarly modified, and is reckoned as the first hypural plate (1). The basal portion of this arch on each side is enlarged into a rounded head, which fits into a corresponding depression of the underside of the vertebra and forms what seems to be a definite joint. The main stem of this bone on each side is flattened towards its outer extremity, where it joins its fellow of the opposite side, and has much the form of the preceding hæmal arch; but towards its proximal part each limb of the arch sends a broad plate forwards, and a process for muscular attachment is seen upon its outer side. The main caudal artery passes through this arch, and then seems to pass backwards along the upper surface of the second hypural bone (2). From each side of the fifth vertebra another bony process arises (*sp.* 1), which passes backwards and upwards along the sides of the notochord as a protective splint, and giving off a long plate-like process from its upper and inner side, forms, with the corresponding bone of the opposite side, a roof-like covering for the notochord. Two other splint-like bones (*sp.* 2) partly overlap these processes, and being lower down on the sides and somewhat more behind, still further protect the notochord. Beyond these a small double-curved bone is seen (*sp.* 3) lying at the sides of the notochord, the latter, however, being free for some distance beyond it. Only one of these bones is seen in the preparation, but doubtless it is one of a pair, similar to those seen in the carp's tail at the same place. Besides the modified hæmal arch above mentioned (fig. 1, No. 1), it will be seen that there are six other broad plates placed below the notochord. Taking No. 1 as the first hypural, it will be noticed that the second (2) is much broader at its outer part, and forms a triangular plate; but its proximal part could not be traced into connection with the vertebral column, although in the adult this connection does take place. The third plate is narrower, and abuts upon the sixth vertebra of the figure. The fourth plate is again triangular, and its proximal end abuts upon the notochord. The outer and lower corner is not ossified, but remains imperfect. At first I thought this was accidental, but it seems to be constant, and to remain imperfect even in the adult. The fifth, sixth, and seventh plates are gradually reduced in size, and become less triangular. The proximal part of

each of these hypural plates, excepting No. 2, is broad and hollowed, but apparently not for the passage of vessels. Between the end of the notochord and the neural spine of the last imperfect vertebra there are three bones (*ep.*), which appear like neural spines, but are not connected with any of the surrounding bones; they correspond with those in the *Gasterosteus* tail, called *epiurals* by Prof. Huxley.

The tail of the adult sprat differs from that above described—first, in the enlargement of the splints and protective processes of the fifth vertebra, which now completely cover the notochord at its sides; secondly, in the covering up or obliteration of the bony vertebral segments behind the fifth vertebra; and thirdly, in the hypural plate No. 2 becoming connected by bony tissue with the fifth vertebra.

A comparison of the sprat's tail with those of the stickleback and flounder shows that it differs from them in three most important particulars, namely, in the first place the notochord is not ossified or enclosed in a long urostyle, but is only protected at the sides by splint-like bones, beyond which it projects for a considerable distance; secondly, the upturned portion of the notochord is segmented in an early stage; and thirdly, in place of the two hypural plates, the sprat has seven plates which bear the tail fin-rays.

The tail of the salmon described by Kölliker* and also by Bruch† agrees essentially with that of the sprat in all the three points just mentioned. The greatest divergence from the sprat form of tail which I have yet seen among the Teleostean fishes is that of the cod and that of the eel.

In the specimen of an adult cod-fish tail which is now before me, there are about 50 fin rays, and of these about 23 are placed above the end of the notochord, and 27 below, so that the displacement of the end of the notochord is only upwards for the space of two fin rays, and at first the tail appears to be diphycercal; besides this, according to my reckoning, there is only one hypural plate. Prof. Alex. Agassiz speaks of two hypurals in the embryo cod; but this difference is not one of facts, but of interpretation. The hæmal arches become gradually enlarged, and assume the form of

* "Ueber das Ende der Wirbelsaüle der Ganoiden," &c., Leipzig, 1860.

† "Vergleichende Osteologie des Rheinlachses" (Salmo salar, L.). Mainz, 1861.

hypural plates. In counting the hypural bones in the stickleback, sprat, carp, and flounder, I have regarded as the last hæmal arch, the hindermost one which has a corresponding neural arch fully developed. The first bone beyond this I have called the first hypural, its neural arch being short and modified. According to this mode of reckoning, the cod has *one* hypural, the stickleback and flounder *two*, the sprat, carp, and salmon *seven*.

It is proposed now to glance at the different groups of fishes, and see which of these forms of tails occur in each of them.

1. *Pharyngobranchii.*—This group includes but one form, the *Amphioxus lanceolatus;* in it the notochord is persistent, and ends in a point in the middle of the tail. It agrees therefore with the earliest stage of the flounder noticed by Prof. A. Agassiz, and is diphycercal.

2. *Marsipobranchii.*—The lampreys and hags which compose this group, although much higher in the scale in other respects, agree with the *Amphioxus* in having a persistent notochord, which terminates in a point in the middle of the tail-fin. These fishes therefore, likewise agree with stage 1 of the flounder, and are diphycercal.

3. *Dipnoi.*—Although the fishes of this group, *Lepidosiren*, *Protopterus*, and *Ceratodus*, are so highly developed in many points of their structure, yet in the form of their tails they are very lowly; and consequently, in the present instance, are taken early in the series, although mostly placed as the highest group of the fishes, because they show affinity with the Amphibia in having lungs as well as gills. All these fishes have the notochord persistent, and ending in the middle of the tail without turning upwards. They are diphycercal, like groups 1 and 2, and agree with stage 1 of the flounder.

4. *Elasmobranchii.*—The sharks, rays, and chimæra which constitute this group exhibit much diversity as to the extent of ossification of the vertebral column. In some the notochord is persistent, in others the vertebræ are fully ossified; there is likewise much diversity in the form of the tail. Concerning this group Prof. Huxley says:*—" The terminal part of the notochord is never enclosed within a continuous bony sheath or *urostyle.* The extremity of the vertebral column is generally bent up . . . Elasmobranchs with tails of this conformation are truly

* " Anatomy of Vertebrated Animals, 1871," p. 127.

heterocercal. The monkfish (*Squatina*) and many other *Elasmobranchii* are more diphycercal than heterocercal."

Among the Elasmobranchs therefore, we have forms of tails varying from stage 1 to stage 3 of the flounder. It is worthy of remark that in this group we never find the *homocercal* form, for to whatever extent the end of the column may be bent up, hypural plates are never developed.

5. *Ganoidei.*—The recent Ganoids may be divided into two groups, the one including the sturgeon (*Acipenser*), *Spatularia*, and *Scapirhynchus*, the second including *Lepidosteus, Polypterus*, and *Amia.*

(*a*) In the first group the tails are all heterocercal, the persistent notochord extending into the fleshy upwardly directed termination of the body, while the tail-fin is placed almost wholly below it. The tails therefore of these are like the heterocercal Elasmobranchs, and agree with the heterocercal condition of the flounder embryo. Stage 3.

(*b*) In the second group of Ganoids we find great diversity of tail development. In all the recent forms the vertebral column consists of well-developed bone, and it is only the extreme end of the notochord which remains unossified. *Polypterus* has the tail externally as nearly as possible alike above and below the middle line, and is not unlike the tail of the *Ceratodus.* Internally, however, it is found that the vertebræ become smaller and smaller, and terminate in a cartilaginous style slightly turned upwards, with the extremity turned down again. One or two somewhat enlarged hæmal spines represent hypural bones, and the fin rays are arranged nearly equally above and below; but on counting them it is found that while there are only 8 fin rays above, there are 14 below the termination of the notochord. This tail therefore may be regarded as between the diphycercal and the heterocercal forms, or it may be a homocercal of the cod-fish type, representing in a well-ossified condition, the earliest stage of the upward turning of the tail in the embryo flounder. *Lepidosteus* has its tail externally distinctly heterocercal, although not so markedly so as is the shark's and sturgeon's. The vertebral column, which is well ossified, passes gradually upwards, the vertebræ decreasing in size, and terminates in a long cartilaginous style in the upper edge of the tail fin. The tail, therefore, is wholly below the vertebral column, and is supported by numerous inferior vertebral arches (14

or 15), which gradually decrease in size as we trace them backwards. This tail is consequently truly heterocercal, although less obviously so externally than in some other forms. It corresponds to the period of the embryo flounder, stage 7, but with the embryonic caudal fin obliterated. The *Amia* has the fleshy lobe of the tail externally very nearly equal above and below the middle line, but internally the ossified vertebral column is more suddenly bent upwards than it is in *Lepidosteus*, and is continued by a cartilaginous style into the uppermost border of the tail, so that the latter is almost wholly below the vertebral column. The hæmal arches form such a regularly continuous series that one cannot say definitely which should be regarded as hypural plates. About 16 or 17 of the hæmal spines support the tail fin-rays, and the terminal 8 have no corresponding neural arches. This tail makes a much nearer approach to the homocercal than any we have yet considered, the outer form showing but little inequality; but still there is a slight preponderance of the upper part of the fleshy portion. It seems to me, therefore, to represent a somewhat later stage of development than the *Lepidosteus*, but nevertheless to be a truly heterocercal tail. Stage 10.

6. *Teleostei.*—All the members of this group of the bony fishes appear to have homocercal tails, and it is generally said to be one of the characteristics of the Teleostei. But, as we have already seen, there is considerable variation in the structure, although this variation may be within the limits of the homocercal group.

The tail of the eel seems to be the nearest approach to the diphycercal form.

The variation in the structure, as already pointed out, chiefly concerns the number of hypural bones developed, there being but one hypural in the cod, two in the stickleback, and seven in the sprat.

The homocercal tails also differ in the manner in which the upturned end of the vertebral column is ossified. The stickleback has this portion of the notochord ossified in one piece, and in the adult there is no part of the notochord unossified. In the sprat, four or five bony segments are to be distinguished at one stage of development, but the end of the notochord is never altogether ossified. The salmon's tail has likewise several distinct vertebral segments in the upturned portion, and, according to Bruch's figure (*loc. cit.*), the unossified part of the notochord shows transverse lines, indicative of segmentation.

The homocercal tail is doubtless the most highly developed, that is the most specialized, form to be found among the class of fishes ; and taking the class as a whole, there seems to be a gradual development traceable from the lowest to the highest. But if we endeavour to arrange the fishes in a linear series, we find that it cannot be done, and this is more especially the case when the whole organization of each group is considered.

To take perhaps the most remarkable instance, the *Dipnoi*. These fishes, although much below the *Teleostei*, in the form of the tail and structure of the skeleton generally, yet in the possession of lungs and other characters they are much above them. It is obvious, therefore, that the Teleostei are not derived from the *Dipnoi*, nor *vice versâ ;* the relationship which exists between the different groups of recent fishes is not one of direct descent the one from the other, but that of common parentage, not one line of descent, but many. And this leads us to inquire into the history of fishes in past times, and more especially to see what information can be gained from the study of fossil fishes' tails.

Part II.

COMPARISON OF RECENT WITH FOSSIL FISHES' TAILS.

The possibility of a parallelism between the development of the tail of a high-class fish of the present day and the development of fishes' tails during geological times, has not escaped the notice of those astute observers who have already studied this matter. The history of the different opinions on this subject is fully stated by Profs. Huxley and A. Agassiz (*loc. cit.*), and it will only be necessary now to mention the more prominent points of this discussion. MM. Agassiz and Vogt were of opinion that such a parallelism did exist, because they were under the impression that the tail of the salmon, which in a young condition is heterocercal, became in the adult truly homocercal (that is, diphycercal as we now understand it) and seeing that among the older fossil fishes the heterocercal tail predominated, and that the homocercal appeared later and superseded it, there seemed to be a kind of parallel development. M. Van Beneden, finding that the earliest condition of the Plagiostomes was diphycercal, came to just the opposite conclusion, because, for such a parallelism to exist, the oldest forms ought to have been diphycercal, whereas they were heterocercal. Prof. Huxley was also of opinion that such a parallelism could not be traced, because he had shown that the apparently homocercal fishes were really only heterocercal

tails disguised. Prof. Alex. Agassiz, having worked out the development of some of the Teleostean fishes, is led to the conclusion that although MM. Agassiz and Vogt were mistaken as to their facts, yet, in his opinion, their generalization was in the main correct. He points out that, among the Devonian fishes, there are truly diphycercal tails, and every intermediate stage between this and the heterocercal form, and following on into the Secondary rocks, he traces through several forms the gradual equalizing of the tail lobes, and the gradual approach to an externally homocercal tail.

While accepting the facts brought forward by Prof. A. Agassiz, I cannot feel that this parallelism is altogether satisfactory. For although the facts probably indicate a gradual advance in the structure of the tail of Ganoid fishes, yet it must be borne in mind that it is only in the Ganoid group, and besides this it must be remembered that, in the Devonian rocks, we find Ganoid fishes, not of the lowest type only, but of every form, from the diphycercal to the heterocercal, that is to say, of just those forms which are found among Ganoids living at the present day. And it might be equally well argued that, so far as we have any evidence, these types have been persistent through all time. And still further, the oldest known fishes' tail, that of *Cephalaspis*, from the Upper Ludlow rocks, is heterocercal. On the other hand, it is true that some of the tails of Ganoids in the Secondary rocks become more nearly homocercal than any that are to be found in the Palæozoic strata. It would be very interesting to know whether these highest forms of Ganoids have their internal skeletal structure more like the Teleostean homocercal tails or not. In other words, we want to know whether these Secondary Ganoids were really advancing towards the Teleostei, or whether they were only more advanced on their own particular lines of development.

Some fresh points of interest are to be found by taking each group of fishes and tracing the different forms of tails which they present in the various geological formations.

Representatives of the two lowest groups of fishes, the Pharyngobranchii and the Marsipobranchii, we cannot expect to find fossil, inasmuch as they have no hard parts which are likely to be preserved. The tooth-like fossils from Silurian rocks, which have been called Conodonts, are probably not parts of fishes allied to the lampreys, as they were at one time thought to be, but remains of annelids.

Dipnoi.—This group of fishes is known to us for the first time

in the Devonian rocks, where it is represented by the genera *Dipterus* and *Conchodus*. The tail of *Dipterus* is heterocercal, and resembles stage 4 or 5 in the development of the flounder. *Ctenodus*, from the Coal Measures, probably belongs to this group, but its tail is not known. Teeth of *Ceratodus* have been found in the Trias and Oolite, but from that time nothing more is known of this group of fishes until the present day, and now we find it represented by *Lepidosiren*, *Protopterus*, and *Ceratodus*, all these three having diphycercal tails. Looked at, therefore, in the light of embryological development, the Devonian *Dipterus* is more highly developed than its recent representatives.

ELASMOBRANCHII.—This group of the sharks and rays is first found fossil in the Upper Ludlow Rocks, where it is represented by the spiny defences called *Onchus*, but no other part of the fish is known. From the Ludlow onwards to the present day, teeth and spines of sharks are met with in all marine deposits, but the forms of their bodies are unknown, so that we cannot say what kind of tail they had.

GANOIDEI.—By far the larger number of the fishes from the Palæozoic and Mesozoic formations belong to this group, and they present so many different forms that it has been found necessary to divide it into seven sub-orders, four of which have living representatives, and the others are extinct. It will be well to take each group separately.

1. *Amiadæ.* The *Amia* is the only form in this sub-order, and is not found fossilized.

2. *Lepidosteidæ.* Most of the genera from the Devonian and Carboniferous Rocks, which were at one time placed in this family, are now referred by Dr. Traquair to the *Palæoniscidæ*, a sub-division of the *Acipenseroidei* (*vide* Palæontographical Society, 1877).

It is in the Secondary Rocks that the Lepidosteidæ have their greatest development, and present us with the widest variety of form, for although we find no diphycercal tail, and the extreme heterocercal is the lowest type, yet, on the other hand, we get the highest type known among the Ganoids, so far as we can judge by outward appearance, for several genera have apparently homocercal tails.

Eugnathus, from the Lias, and *Ophiopsis*, from the Purbeck, show the lowest type of tail in the Secondary Rocks; they are heterocercal, and agree with stage 4 or 5 of the flounder.

Æchmodus, *Semionotus*, and *Pholidophorus*, from the Lias, *Lepidotus*, which is found from the Lias to the Wealden, and *Histionotus*, from the Purbeck, all have tails approaching that of *Lepidosteus*, and agreeing with stage 5. The *Dapedius*, from the Lias, makes even a nearer approach to homocercality stage 5 or 7 ; but, according to Agassiz' restoration,* it is in the *Pachycormus* from the Lias, the *Sauropsis* from the Oolite, and the *Leptolepis*, which is found from the Lias to the Purbeck, that we see the highest development of the Ganoid tail, for externally they are just as much homocercal as any Teleostean fish. We have no evidence to show that this is really identical with the Teleostean homocercality, and I think future research will prove that the Ganoid homocercality differs from that of the Teleostean. At present they must be regarded as stage 9 or 11 of the flounders' development.

3. *Crossopterigidæ*. There is much variation in the tails of these fishes, even among those which are found in the Devonian Rocks. Thus :—The genera *Glyptolæmus* and *Glyptopomus* having the tail straight and equal above and below, seem to resemble the earliest condition of the embryo, stage 1.

Holoptychius and *Gyroptychius* may be taken to represent stage 2, as they have a slight upward tendency.

Glyptolepis has a greater development of the lower caudal lobe, and represents the stage 3.

Diplopterus has a distinct heterocercal tail, with a well-developed lower lobe, and would represent stage 4 or 5.

Tristichopterus has a most remarkable tail. Its upper and lower lobes are nearly equal, but the end of the body extends upwards and backwards through this, so as to form another smaller lobe within the other two. This tail is heterocercal, and would represent stage 6 or 7.

In the Coal Measures the Crossopterigidæ are found represented by *Holoptychius* and *Megalichthys*, the former resembling stage 2, while *Megalichthys* is most like stage 3.

The *Cœlacanthini*, a peculiar group of the Crossopterigidæ, closely allied to the Dipnoi, are represented in the Coal Measure by *Cœlacanthus*, and in the Mesozoic Rocks by *Undina*, *Holophagus*, and *Macropoma*, in all of which the notochord was unossified and the tail diphycercal, stage 1. No Crossopterigian is known in Tertiary strata, but at the present day it is represented by *Polypterus*

* "Poissons Fossiles," vol. i.. pls. A to G. 1833-43.

and *Calamoichthys* of N. African rivers, the tail of the former being apparently diphycercal, but internally slightly upturned, much as in the cod-fish.

4. *Acipenseroidei.* This group, which has been established by Dr. Traquair (Palæontographical Society, 1877), to include the recent *Chondrosteidæ* and certain fossil forms, is represented in the Devonian Rocks by *Cheirolepis;* and in the Coal Measures, Permian, Trias and Lias, by such genera as *Palæoniscus*, *Amblypterus* and *Pygopterus*, all of which have tails resembling stage 4 or 5. The *Chondrosteidæ* are represented in the Lias by *Chondrosteus*, which has a persistent notochord and a strongly heterocercal tail, like its recent representatives the sturgeon, *Spatularia*, and *Scapirhynchus*. Stage 3. The sturgeon is known from the London Clay.

5. *Cephalaspidæ.* These fishes, characterized by having their heads covered by a continuous shield, are the oldest representatives of the class *Pisces.* The *Cephalaspis*, from the Upper Ludlow, has a heterocercal tail representing stage 3. The *Pteraspis*, from the Lower Ludlow, is the earliest fish yet found, and so far as known the tail was heterocercal.

6. *Placodermi.* This is another remarkable group of fishes, only known in the Devonian and Carboniferous strata. One of these, *Coccosteus*, had a truly diphycercal tail, and persistent notochord, and possibly the others were the same. Stage 1.

7. *Acanthodidæ.* This, like the last group, is confined to the Devonian and Carboniferous rocks. These fish have the body covered with shagreen, and have long spines to the dorsal, pectoral and ventral fins. Their tails are strongly heterocercal and represent stage 4.

Taking the Ganoids as a whole, we see that their earliest representatives were heterocercal, *Cephalaspis*, &c., but in the oldest beds where they occur in any numbers, we find every form of tail, from the diphycercal, as in *Coccosteus* and *Glyptolæmus*, to the extremely heterocercal, as in *Tristichopterus*, while, as M. Alex. Agassiz truly states, we have no such form of tail as that of Lepidosteus, which makes a very close approach to the externally homocercal form, until we get to the Secondary strata, where *Lepidotus* and *Pachycormus* are perhaps the most highly developed forms, and judging from M. Agassiz's restorations, had homocercal tails.

Teleostei. The Teleostei are not certainly met with in the fossil state until we get up as far as the Cretaceous Rocks, but there we

find highly specialized forms, some being representatives of living genera and having their tails formed on precisely the same plan as those which we call homocercal among recent Teleostei. It is not proposed to carry these comparisons any further at present, but it is hoped that the accompanying table (p. 96), which shows some of the facts above referred to, will help to put them in a clearer light.

This study of the fossil forms in the light of development leads us to the following conclusions :—

1. The *Dipnoi* having its earliest representative Dipterus, with a heterocercal tail, and its recent examples with diphycercal tails, shows a retrogression and not an advance.

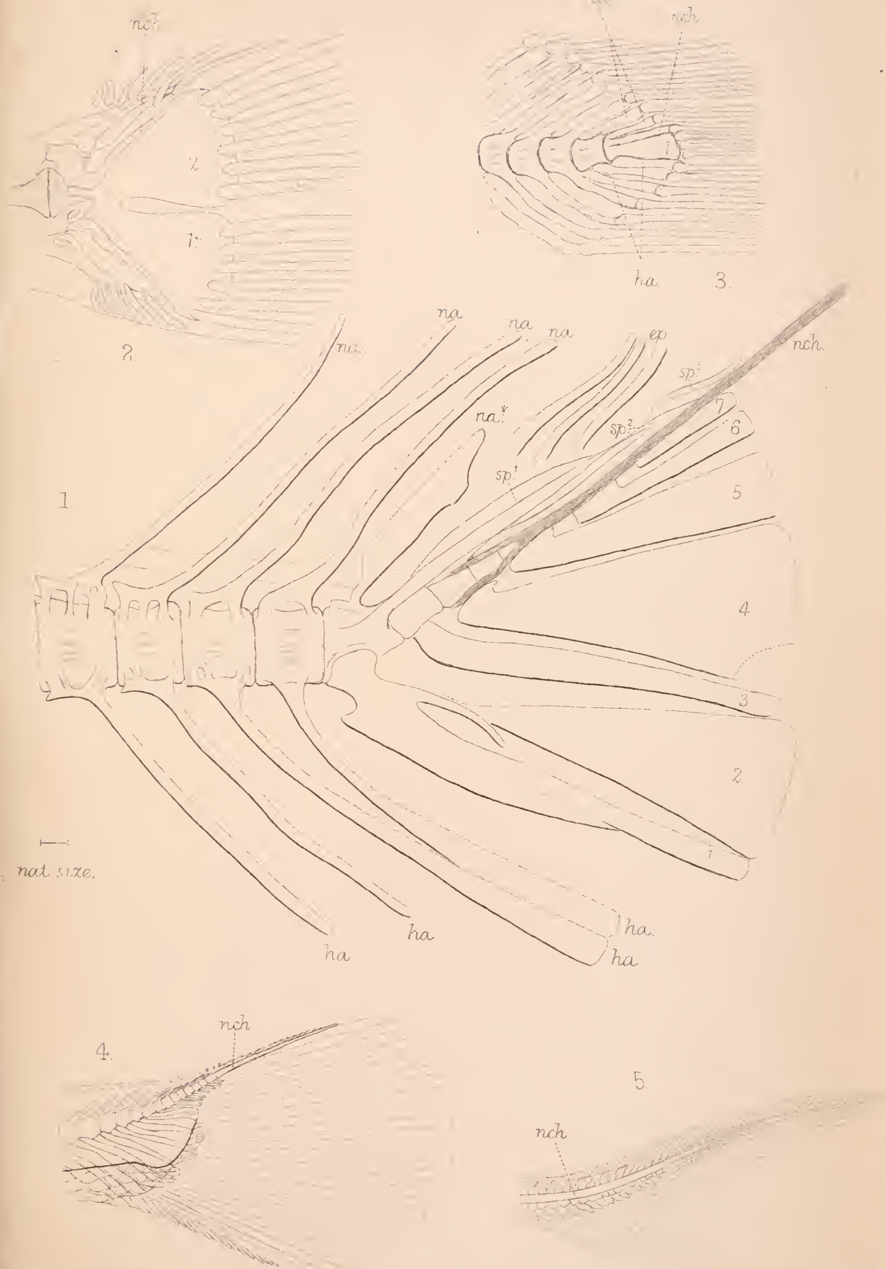
2. The *Elasmobranchii* have probably remained much the same through all time since their first appearance in the Ludlow to the present day.

3. The *Ganoidei*, in their earliest known representative, *Cephalaspis*, were heterocercal, and therefore somewhat advanced, while in the Devonian Rocks we have all the forms of tails which are now living, with the exception possibly of the *Amia*, and might, therefore, be held to show a persistence of type through time, and not an advance.

On the other hand, although heterocercal tails are found in these older rocks, yet the highest type is more embryonic than many that are met with in the Secondary strata, where forms occur as high, or even higher than, those of the present day. And consequently the Ganoids of the Secondary strata are of a higher type than those of the Primary rocks. But with regard to the Secondary Ganoids, it must be remembered that we do not here, any more than in the older formations, find a gradual advance from the forms of the lowest Secondary Rocks to the highest ; for in the Lias we have fishes with tails as highly organized as we find in the Purbecks, and these agreeing as closely as possible with recent forms. So that we cannot say the Ganoids have advanced in structure between the Lias and the present day.

4. *Teleostei*, when first we recognise them with certainty, in the later Cretaceous rocks, they have an organization as high, so far as we can tell, as any living representative of the group.

It is a remarkable fact that the Teleostei are first known at the time when the Ganoids are declining, and one is naturally led to ask whether the one has descended from the other. At present this cannot be answered ; but it seems quite possible, so far as the form of the



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tail is concerned, that the Teleostei may have so descended, for it is quite conceivable that a form of tail like that of *Lepidosteus* might, with comparatively little change, become such a homocercal form as we get in the sprat. If the Teleostei have been thus evolved, the links of the chain connecting the two groups are still unknown.

Before these problems can be solved there is much work to be done both in working out the structure of fossil forms and also in the investigation of the embryology of recent Teleostean and other fishes.

DESCRIPTION OF PLATE III.

Fig. 1.—Tail of a young Sprat (*Harenga sprattus*), with the four preceding vertebræ; enlarged about 25 diameters. The fin rays are omitted for the sake of clearness. *na*, neural arches; *na**, modified neural arch ; *ha*, hæmal arches; 1 to 7, series of 7 hypural bones. *sp*. 1, one of a pair of splint-like processes arising from the first upwardly directed vertebra, and protecting part of the unossified notochord; *sp*. 2, *sp*. 3, two other splint-like bones, which, with corresponding bones on the opposite side, still further protect the notochord; *nch*, the unossified notochord, extending beyond the hypural bones ; *ep*, epiurals; these appear to be serially homologous, with the spines of the neural arches, but are incomplete below.

Fig. 2.—Tail of a Stickleback (*Gasterosteus*), enlarged, after Huxley. Only a portion of the fin-rays are represented. 1, 2, hypural bones; *nch*, notochord ossified and fixed to the border of the uppermost hypural bone.

Fig. 3.—Central portion of the tail of a Codfish (*Gadus morrhua*), natural size. *na*, two hindermost neural arches; *ha*, two hindermost hæmal arches; 1, the single hypural bone; *nch*, the ossified notochord firmly attached to the upper border of the hypural bone.

Fig. 4.—Tail of the Bony Pike (*Lepidosteus*), after Kölliker, reduced: *nch*, notochord; in front of this are shown a series of vertebræ, with their neural and hæmal arches, all of which become smaller as they are traced backwards.

Fig. 5.—Tail of Sturgeon (*Acipenser*), much reduced, after Agassiz. *nch*, notochord; above and below this are shown the large series of cartilages representing the neural and hæmal arches.

The figures indicate, as nearly as possible, the stage in the development

	Pharyngo-branchii.	Marsipo-branchii	Dipnoi.	Elasmo-branchii.	Ganoidei.	
					Acanthodidæ.	*Placodermi.*
Recent ...	Amphioxus, 1	Petromyzon, 1	Ceratodus, 1 Lepidosiren, 1	Various Sharks, 1 to 3	...	...
Tertiary ...	...	...	...	Lamna, &c....	...	...
Cretaceous.	...	...	...	...	...	...
Wealden ...	...	...	...	...	...	...
Purbeck ...	...	...	...	...	...	...
Oolite ...	...	...	Ceratodus ...	...	...	...
Lias ...	...	...	...	Hybodus ...	...	...
Rhætic & Trias	...	...	Ceratodus ...	Hybodus ...	...	...
Permian ...	...	...	...	...	...	...
Carboniferous.	...	...	Ctenodus ...	Gyracanthus	Acanthodes, 4	...
Devonian ...	...	...	Dipterus, 4 or 5	...	Cheiracanthus, 4 Diplacanthus, 4	Coccosteus, 1 Pterichthys
Upper Ludlow	...	...	...	Onchus ...	...	...
Lower Ludlow	...	...	...	...	...	...

of the Flounder's tail with which each form most nearly agrees.

Ganoidei.						Teleostei.
Cephalaspidæ.	*Acipenseroidei.*	*Crossopterigidæ.*	*Cœlacanthini.*	*Lepidosteidæ.*	*Amiadæ.*	
...	Acipenser, 3	Polypterus, 2	...	Lepidosteus, 7	Amia, 10	Perca, &c., 12
...	Acipenser, 3	...	...	Lepidosteus, 7	...	Many forms, 12
...	...	...	Macropoma, 1	...	...	Beryx, 12
...	...	...	...	Lepidotus, 5	...	...
...	...	...	...	Ophiopsis, 4 Histionotus, 5 Leptolepis, 9 or 11	...	...
...	...	...	...	Sauropsis, 9 or 11	...	Thrissops, 12?
...	Chondrosteus, 3	...	Holophagus, 1	Eugnathus, 4 or 5 Æchmodus, 5 Dapedius, 5 or 7 Pachycormus, 9 or 11	...	...
...	...	...	...	Dipteronotus, 5	...	...
...	Palæoniscus, 4 or 5	...	...	...	...	...
...	Amblypterus, 4 Pygopterus, 4	Holoptychius, 2 Megalichthys, 3	Cœlacanthus, 1	...	...	...
...	Cheirolepis, 5	Glyptolæmus, 1 Gyroptychius, 2 Glyptolepis, 3 Diplopterus, 4 Tristichopterus, 6 or 7	...	...	...	...
Cephalaspis, 3	...	...	...	...	...	...
Pteraspis	...	...	...	...	...	...

PROCEEDINGS.

January 13th, 1882.—Conversational Meeting.

The following objects were exhibited :—

Corethra plumicornis, shown in a new growing slide for constant observation	The President.
Cuticle of Apple-leaf, polarized, showing the hairs &c.	Mr. F. W. Andrew.
Tracheæ of *Dytiscus marginalis*	Mr. W. R. Browne.
Polysiphonia fibrata (marine alga) in fruit, showing spores in various stages of development	Mr. T. H. Buffham.
Nauplius of *Lepas*, showing Diatoms in stomach; from H.M.S. Challenger dredging	Mr. H. G. Glasspoole.
Sting of Scorpion	Mr. H. R. Gregory.
Anamesite Lava from Ætna, containing crystals of Zeolite	Mr. H. Hensoldt.
Crystals of native Silver...	Dr. Matthews.
Volvox globator, shown by green polarized light	" "
Cepheus occellatus (new species) showing the eye-like form of the stigmata	Mr. A. D. Michael.
Leaf of *Pistia stratiotes*	Mr. H. Morland.
Asterionella formosa	Mr. G. Sturt.
Transverse section of stem of Misletoe double stained	Mr. J. Woollett.

Attendance—Members, 56; Visitors, 6.

January 27th, 1882.—Ordinary Meeting.

T. Charters White, Esq., M.R.C.S., &c., President, in the Chair.

The minutes of the preceding meeting were read and confirmed.

The Rev. Thos. R. Jones, M.A., was balloted for and duly elected a member of the Club.

The following donations and purchases were announced :—

"Proceedings of the Royal Society" ...	from the Society.
"Journal of the Linnean Society"... ...	" Mr. T. C. White.

"Proceedings of the Epping Forest Natural History Club"	from the Club.
"Proceedings of the Belgian Microscopical Society"	" " Society.
"Science Gossip"	" " Publisher.
"The Analyst"	" " "
"The Northern Microscopist"	" " "
"The American Monthly Microscopical Journal"	in exchange.
"Handbook of the Wild Silks of India"	from the Science and Art Department.
"Annals of Natural History"	purchased.
"Dr. Cooke's Fresh Water Algæ" ...	"
Three Slides	from the President.

The thanks of the meeting were voted to the donors.

Mr. E. T. Newton exhibited and described a new form of microtome, devised by Professor Miall.

The President was sure that the members would heartily join in a vote of thanks to Mr. Newton for bringing this apparatus before them. Many scientific men were not very wealthy, and could ill afford to purchase elaborate and costly section machines. Whatever therefore could be done to effect economy without impairing efficiency, was very desirable. A vote of thanks was put and carried unanimously.

Mr. J. W. Groves said he must thank Mr. Newton for bringing up a machine that seemed likely to be useful for tolerably thin sections; he thought, however, that very thin sections would be likely to get cut wedge-shaped. He also thought that there was an objection to the top plate being of brass, because the razor would be apt to dig into it in the act of cutting; for this reason he thought a glass plate would be much better.

Mr. Newton said that practically the first-mentioned difficulty did not arise, because they must cut about 30 sections before getting the whole of the error. He hardly supposed anyone would try to cut sections $\frac{1}{1000}$ of an inch in thickness with such a machine, although it could be done.

Mr. Hailes said that the tendency to the wedge shape would not arise if the plate was screwed on the thread and faced up in the lathe; it would then be practically true.

Mr. J. G. Waller read a paper on "Sand."

Mr. M. Hawkins Johnson in reply to the President, said he understood the question before them to be, "How was it to be accounted for that sand contained such a great quantity of quartz but so little flint?" He confessed that he did not know much about it, but perhaps he might speculate a little. If a number of chalk pebbles were thrown together cn a beach by the action of the waves, they would be found to collide with much less force than they would if thrown in the air; the amount of force exerted upon each was very small, and they might rather be said to roll together. The result of a blow upon a flint would be to produce a conical fissure, and when a number of these were made, small scaly pieces got

broken off in just the condition to be dissolved. On the granite hills they would find masses of *débris* along the roads and watercourses which looked like ground rice; this was the quartz which had been left by the rain after the mica and felspar had been washed out. There occurred to him a notable instance of sand which was not quartz, and that was the sand from the River Parrot, of which what were called Bath bricks were made. This sand contained a great deal of matter of very much the same character as flint, to which the peculiar sharpness and cutting property of the material was due; it was not exactly flint; probably it was chert.

The President said Mr. Waller had referred to the use made by small animals of the grains of quartz; he should like to ask if it was found that the arenaceous Foraminifera selected quartz in the same way?

Mr. E. T. Newton said they were much indebted to Mr. Waller for bringing this subject forward. There were one or two things in connection with it which he thought were not sufficiently noticed in books. Many people were not aware that flint was so soluble as it was. Quartz was very much harder and more durable, so that under the action of water and weather the flint disappeared but the quartz did not, and so, as the quartz was likely to stay and the flint to dissolve away, in course of time only the quartz was left. It should be remembered too, that in earlier times England was not a separate island; the North Sea was at that time probably an estuary; and the climate being glacial, vast quantities of *débris* were doubtless brought down and deposited. As to the small creatures mentioned as having their cases composed only of quartz grains, of course that would necessarily follow from the fact of their not being able to get anything else.

Mr. Michael said it struck him in the first place that the extreme ease with which flint could be broken up might have something to do with the matter. Some years ago when silica was wanted for glazing china, it was obtained by heating flint and dropping it into water; it could be then pounded up quite easily, and formed a colloid with water. Another point was, if the sand beaches were to be attributed to the attrition of the granite, it was a singular fact that sand was so deficient in granite districts. Such was the case, the beach on the granite coasts consisting almost entirely of fine powdered shells, the deposit being in some parts 30ft. deep. It was so in Cornwall, and he believed it was so too in the granite districts of the Highlands and the Isle of Arran, where, though the powdered granite was used for road making, there was very little sand.

Mr. M. Hawkins Johnson said that though not exactly *apropos* of the paper, he might mention that the probability was that where the action of the sea was sufficiently violent to produce granite cliffs it would no doubt be sufficiently so to wash away the detritus. An instance occurred to him in the case of two rivers in the north of Scotland, the Spey and the Findhorn; both of these brought down granite detritus, and there was in that district an immense quantity of sand; but the sea there was not encroaching as in some other portions of the coast. Mr. Johnson then showed by means of a diagram drawn upon the board that the original construction of

the flint being organic the conditions of its structure would materially aid in its disintegration.

Dr. Matthews mentioned the circumstance that Wedgewood saw a farrier drop hot flints into water in order to be able afterwards to powder them, and that this was the origin of their use in china making; also that simple exposure to the weather was all that was required to disintegrate granite, the result being the formation of china clay. He should like to ask what was the chemical difference between flint and quartz, seeing that quartz would polarize and flint would not?

Mr. Hawkins Johnson said it was not strictly correct to say that flint did not polarize; glass and other colloids would not, but flint itself would, that was if it was examined with crossed prisms, it would restore the light; but it would not show colour as quartz did. Organic silica, such as sponge spicules, did not polarize.

Mr. Waller said that when he made use of the term "polarize," he meant to express the difference which there was between the two substances—quartz giving those brilliant colours which they were so well acquainted with; he had mentioned, however, that flint was susceptible to polarized light. The matter was one which he thought wanted more study, as there were other kinds of silex which certainly did polarize, but which did not belong to the chalk flints, and which could not be classed with the quartz.

The thanks of the meeting were unanimously voted to Mr. Waller for his paper.

The proceedings terminated with the usual Conversazione, at which the following objects were exhibited.—

Hipperic acid in arabin ... ... Bichromate of potassium in arabin ...	the President.
Cuticle of Lavender leaf, stained, showing stellate and branched hairs ...	Mr. F. W. Andrew.
Fangs of Centipede, showing tuberculated poison glands...	Mr. H. E. Freeman.
Foraminifera from Teneriffe	Mr. H. F. Hailes.
Lophopus crystallinus, from Epping Forest ...	Mr. J. D. Hardy.
Nelson's Flaked Gelatine, polarized ...	Mr. T. S. Morten.
Eyes of a *Mygale*, a reputed bird-catching spider	Mr. F. Wood.

Attendance—Members, 55; Visitors, 5.

February 10th, 1882.—Conversational Meeting.

The following objects were exhibited:—

Larva of *Corethra plumicornis*, $\frac{1}{3}$ inch objective	The President.
Section of Oat	Mr. F. W. Andrew.
Section of shell of *Pinna ingens*	Mr. W. R. Browne.
Mymar pulchellus, female, the Battledore-winged Fly	Mr. F. Enock.

Foraminifera from Challenger dredgings ...	Mr. H. F. Hailes.
Conochilus volvox	Mr. J. D. Hardy.
Leaf of *Listera ovata*, stained	Mr. H. Morland.
Pollen of *Lapergia*	Mr. T. S. Morten.
Parasite of the Spanish Donkey	„ „
Pleurosigma formosum, showing sieve-like structure × 870 diam.; ¼ inch objective and Lieberkühn	Mr. E. M. Nelson.
Arachnoidiscus ornatus, in situ on decalcified Coralline	Mr. B. W. Priest.
Flea of Mouse, *Pulex musculi*	Mr. J. Woollett.

Attendance—Members, 49; Visitors, 6.

February 24th, 1882.—Ordinary Meeting.

T. Charters White, Esq., M.R.C.S., &c., President, in the Chair.

The minutes of the preceding meeting were read and confirmed.

Mr. H. I. Bound, Mr. J. N. Fitch, Mr. L. Greening, and Mr. J. H. Harding, were balloted for, and duly elected members of the Club.

The following additions to the Library Cabinet and Album were announced, and the thanks of the meeting voted to the respective donors:—

"Proceedings of the Royal Society"... ...	from the Society.
"Journal of the Linnean Society"	„ T. C. White.
„ „ Royal Microscopical Society"	„ the Society.
"Proceedings of the Belgian Microscopical Society"	„ „
"Science Gossip"	„ the Publisher.
"The Analyst"	„ „
"The Northern Microscopist"	„ „
Dr. Braithwaite's "British Moss-flora," Part V.	„ the Author.
"The American Naturalist"	in exchange.
„ „ Monthly Microscopical Journal"	„
"Grevillea"	purchased.
"The Annals of Natural History"... ...	„
"The Micrographic Dictionary," Part VII. ...	„
Photograph of Mr. F. S. Morten.	

Mr. Ingpen called attention to the possible value of an aqueous solution of iodine for preserving and mounting *Volvox* and other Algæ. The solution was prepared by adding caustic potash to an alcoholic solution of iodine till it became colourless, avoiding any excess of potash. It should be greatly diluted. He showed specimens of *Volvox* that had been mounted more than a month, and appeared in very good condition.

The President read a paper "On the histological development of the larva of *Corethra plumicornis*.

Mr. Hardy said that he had given the subject some attention, and made some observations upon the air-sacs, with regard to their ultimate use. Two very thin and transparent bodies were attached to the air-sacs (reniform bodies) of the thorax; these bodies, as the air-sacs gradually extended towards the head, were developed into long ear-shaped sacs while inside the body of the larva. When these were perfected, they quickly made their way out of the thorax behind the head, and appeared as two lobes having a peculiar ear-like appearance. They evidently acted as buoys to the now developed pupa, and seemed to have deprived the original air-sacs of their contents, for the latter broke up and dispersed after the extension of the ear-like lobes. While this was going on at the head, the air-sacs of the tail were also tending outward, and at about the same time as the lobes appeared at the head, the sacs of the tail were developed externally into two large flat branchial lobes, having little floating power, so that the pupa swam perpendicularly head upwards. He had also reason to believe that similar larvæ underwent another transformation, and appeared as pupæ swimming head downwards. These latter developed into the gnat (*Culex*), while the former pupæ developed into *Corethra plumicornis.*

The President said that it would be interesting to get the eggs, and ascertain when the air-sacs were first formed.

Mr. Hardy considered that there was a second pupal condition to prepare the insect for its aerial existence.

Mr. Freeman doubted the transformation of the *Corethra* larva into the perfect form of a *Culex.*

The President described the contractile effect produced upon the muscles by treatment with acetic acid.

A vote of thanks to the President for his paper was proposed by Dr. Matthews, and carried unanimously.

Mr. Gilburt described the process of development and liberation of the zoospores of *Vaucharia*, which was at that time abundant at the waterworks of the East London Water Company at Hackney Marshes, the plant being in the most favourable condition for the examination of this interesting portion of its life history.

The President announced the engagements for the ensuing month, and the proceedings concluded with the usual Conversazione, at which the following objects were exhibited :—

Larva of *Corethra plumicornis*	The President.
Section of stem of Mistletoe, stained ...	Mr. F. W. Andrew.
Ship's Barnacles	Mr. H. Epps.
Head and leg of *Crabro cibarius*	Mr. H. E. Freeman.
Fang and poison-bag of American Centipede...	Mr. H. R. Gregory.
Volvox globator, mounted in a solution of iodine and potash	Mr. J. E. Ingpen.
Nest of a trap-door Spider from South America	Dr. Matthews.

Attendance—Members, 56; Visitors, 5.

March 10th, 1882.—Conversational Meeting.

The following objects were exhibited :—

Stellate hairs from Lime tree, polarized ...	Mr. F. W. Andrew.
Marine Alga, *Callithamnion Brodiei*, in fruit, the favellæ containing spores ...	Mr. T. H. Buffham.
Synedra splendens	Mr. A. L. Corbett.
Foraminifera from South Sea Islands ...	Mr. H. G. Glasspoole.
Hoplophora magna (living), showing its power of closing up	Mr. A. D. Michael.
Spermatozoon of *Triton cristatus*, showing the barb on the head × 1200 diam. Powell and Lealand's $\frac{1}{12}$ oil imn., N. A. 1·43.	Mr. E. M. Nelson.
Sections of Coal, prepared by Dr. Reinsch, containing vegetable organisms which have been described as new to science ...	Mr. E. T. Newton.
Cladode and Stem of *Ruscus aculeatus* ...	Mr. J. W. Reid.
Astrolampora (sp. ?) from Nottingham, U.S. ...	Mr. G. Sturt.
Head of House Spider (*Ciniflo similis*), male...	Mr. F. Wood.

Attendance—Members, 50; Visitors, 4.

March 24th, 1882.—Ordinary Meeting.

J. W. Groves, Esq., F.R.M.S., Vice-President, in the Chair.

The minutes of the preceding meeting were read and confirmed.

The following gentlemen were balloted for, and duly elected members of the Club :—Mr. B. Dale, Mr. H. Selby, Mr. W. D. Smith, and Mr. J. Vicars.

The following additions to the Library were announced :—

"Proceedings of the Royal Society" ...	from the Society.
"Journal of the Linnean Society"	„ Mr. T. C. White.
"9th Report, &c., of the New Cross Microscopical Society"	„ the Society.
"Proceedings of the Natural History Society of Glasgow"	„ „
"Proceedings of the Natural History Society of New South Wales"	„ „
"Science Gossip"	„ the Publisher.
"The Analyst"	„ „
"The Northern Microscopist"	„ „
"American Monthly Microscopical Journal"...	in exchange.
2 Parts "Wonders of the Microscope" (old and scarce)	from Mr. Glasspoole.
"Annals of Natural History"	purchased.
"Micrographic Dictionary"	„
2 Parts "Schmidt's Diatomaceæ"	„

The thanks of the meeting were voted to the donors.

The Chairman read a letter from Mr. W. G. Cocks, giving a detailed list of objects found at the last excursion of the Club to Snaresbrook.

Mr. Michael called attention to a slide which he had brought for exhibition, which illustrated the curious fact that many of the Marine Annelids had a proboscis which was revertible, so that the pharynx became an external organ, and practically a supplementary mouth.

The Chairman said it was not always easy to get a mount of this kind, although they might sometimes be fortunate enough to see this curious condition in a living animal. He should like to know how Mr. Michael managed to get the animal in this position, so as to be able to preserve it.

Mr. Michael said it was generally much more of an accident than anything else. He found no better way than to put the creature under the microscope in a watch glass, and observe it until it was in a good position, and then to drop some methylated spirit upon it.

Mr. James Mackenzie exhibited two forms of gas lamp, which he had constructed specially for use with the microscope.

Dr. Matthews inquired if Mr. Mackenzie had tried the effect of an oxidator upon a flat flame gas burner; he thought this would be worth trying.

Mr. Ingpen said that the flat flame shown was larger than was necessary for microscopical purposes.

Mr. Mackenzie considered that a large flame was often wanted.

Dr. Matthews suggested that the burner should be made of steatite with an oxidator above it like a paraffin lamp, and with something like an iris diaphragm below to regulate the draught.

Mr. Mackenzie thought perhaps this might be done; he would try and carry out the suggestion.

Mr. E. T. Newton read a paper "On Fishes' tails," which he illustrated by numerous diagrams and specimens.

On the motion of the Chairman, a vote of thanks to Mr. Newton for his interesting paper was unanimously passed.

The Chairman said that the Committee had that evening passed a resolution protesting against the proposed draining of Epping Forest; a similar course had been adopted by most of the Natural History Societies in and near London. The resolution was then read to, and approved by the meeting.

Notices of meetings and excursions for the ensuing month were then read, and invitations to members to assist at the forthcoming Soirées of the Ealing and Highgate Societies were given. The meeting then terminated with the usual Conversazione, at which the following objects were exhibited:—

Section of a Small Orange	Mr. F. W. Andrew.
Microscope Gas Lamp with Argand burner	Mr. J. Mackenzie.
,, ,, ,, ,, small ditto	
,, ,, ,, ,, Flat flame burner	

Phyllodace, a marine Rapacious Polychætous Annelid, showing the pharynx everted so as to form an external mouth ...	Mr. A. D. Michael.
Tails of Lancelet, Lamprey, Eel, Sprat, Cod, and Carp	Mr. E. T. Newton and Mr. J. W. Reed.

Attendance —Members. 47; Visitors, 4.

April 14th, 1882.—Conversational Meeting.

The following objects were exhibited:—

Branched hairs on leaf of Blanket plant, *Verbascum thapsus*, polarized ...	Mr. F. W. Andrew.
Callithamnion Turneri, Marine Alga, in fruit, showing the tetraspores ...	Mr. T. H. Buffham.
Transverse section of hair of African Elephant	Mr. H. E. Freeman.
Diatoms from Barnes Common	Mr. H. G. Glasspoole.
Stained leaf of *Potamogeton natans*, polarized, showing chains of cells enclosing sphœraphides	Mr. H. Morland.
Nelson's opaque flake gelatine, polarized ...	Mr. T. S. Morten.
Asteromphalus (sp.?)	Mr. G. Sturt.

Attendance—Members, 44; Visitors, 2.

On an Algal Form Growing in a Solution of Cupric Sulphate.

By F. Kitton, Hon. F.R.M.S.

(*Read* April 28th, 1882.)

Some six months ago I filled an "engraver's globe" with a solution of sulphate of copper (afterwards described by me in "Science Gossip"); the proportions were about 2 oz. of a saturated solution to 40 oz. of water; the latter was the water supplied by the Chelsea Company. Before filling the globe I allowed the mixture to remain for three days in a glass vessel, in order that the sulphate of lime and other impurities might subside, and then carefully decanted it into the "globe," leaving about 1 oz. of turbid, almost muddy deposit behind. In a short time the solution lost its transparency, and little flocculent specks could be seen floating about in it, when the globe was shaken; I again poured the solution into the glass vessel, leaving almost all the specks behind. The cloudy appearance arose from a chalky (?) deposit upon the surface of the glass, which I had some difficulty in removing. The solution in the glass was clear, with the exception of a few of the "specks" floating about, and which I removed with a pipette. In the course of a day or two I poured back the solution, and it appeared perfectly transparent; some six weeks afterwards I noticed that many hundreds of these specks had again made their appearance, and I now, for the first time examined them with the microscope, and found that they were some species of Alga, perhaps an imperfect state of *Conferva rivularis*.

The specimen sent with this is mounted in the original solution.

On "The Chromatoscope," A Method of Illuminating Crystals and Similar Objects by Coloured Light.

By J. D. Hardy.

(*Communicated* April 28th, 1882.)

I wish to introduce to your notice this evening a new method of illumination which will be found of great value in mineralogy, crystallography, and on all such material where polarization cannot be applied; and even with objects which will polarize this method is equally applicable (unless it is in experiment or study). It differentiates some objects almost as well as polarization, while the light or brilliancy is much greater, giving to them a beauty and clearness such as have not yet been attainable. I show it here in its simplest form, but it is capable of many modifications, and its cheapness as a substitute for the polarizing apparatus will render it applicable to the cheapest microscopes with very little additional expense.

The construction is as follows :—Taking a spot lens, a short flanged tube is fitted to slide easily inside, and underneath the "spot" when attached to the microscope. I cement a piece of clear glass to the flange (or it may be bevelled in), and to the inner side of the plain glass I put two or three pieces of stained glass, either kept in their places with a little balsam or by another piece of plain glass above them, as in a kaleidoscope. This completes the instrument, which, it will be seen, is as simple as possible. The light is transmitted by the mirror in the usual way, and the revolution of the "Chromatoscope" will show the same effect on crystals, &c., as if they were polarized. Such objects as Sponge spicules, Polycistina, Diatoms, &c., have all their peculiarities rendered more easily visible, and at the same time their appearance is greatly enhanced by the effect of a variety of tints which are not otherwise obtainable. Another advantage is, that crystals can be viewed as if polarized, without being damaged by mounting in balsam, or having a cover-glass over them. The finest spicules of some crystals are thus kept intact, and exhibited with great clearness.

On a Portable Binocular Dissecting and Mounting Microscope.

By the Rev. H. J. Fase.

(*Read* May 26th, 1882.)

It having been suggested that the form of microscope made to meet my own wants might prove useful to others, I gladly, at the request of our Secretary, send it for inspection, together with a few words of explanation.

It may perhaps make more clear the arrangements and general purpose which this microscope is intended to fulfil, if the circumstances which gave rise to its construction are briefly narrated.

Not long since it was my lot to be away from London during a considerable portion of two years, most of the time moving about frequently from place to place.

Occasionally microscopic objects of interest presented themselves, which were in many cases lost or damaged irretrievably, because materials for mounting them were not at hand.

There was no difficulty as to the carriage of a small folding microscope in a portmanteau, but there was found to be, in practice, considerable difficulty in carrying safely and compactly, and so that they might be readily got at and replaced, the many small matters required in dissecting and mounting.

I found it took a lot of time and care to pack them, if there was to be a tolerable hope of their safety in their travels. If this were not accorded to them dire was the consequence apparent when the box containing them was opened, in the shape of an awful smash, and considerable expenditure of glass, not easily replaced in a remote country village.

Balsam, turpentine, glycerine, and methylated spirit are capital things in the right place, but it struck me very forcibly after experience thereof, that the right place for these very insinuating and tenacious media was not on linen, or clothes, hair-brushes

and combs. I therefore sought some arrangement by which all the things required for

1. Dissecting.
2. Mounting, and
3. A binocular for observing could be carried in a compact form.

Although fairly well acquainted with various adaptations and forms of instrument already made, I did not find what I wanted. I therefore set to work to make a model in wood, which should meet the following requirements, viz., that it should contain

I. A full-sized, steady dissecting stage, with absolutely necessary instruments.

Two pairs scissors, knives.

Two pairs forceps, watch-glass, needle points, &c., &c.

II. An arm, so constructed that it would carry—

1. A large low-power lens for dissecting.

2. A ring, into which various objectives could be dropped for the same purpose.

3. A binocular body, which could be easily substituted for the ring, and

(*a*) Permit of investigation of the manner in which the dissection was progressing, and also

(*β*) Be steady enough to make an efficient binocular for ordinary observation.

III. That there should be places in the case for a small number of

1. Cements, and media most usually required by working microscopists.

2. Brushes, dipping tubes, lamp clips, slides, glass circles, troughs, a hot plate, turn-table, packed in such a way that each of them should be safely carried, easily got at, and replaced.

3. That every fitting should be full-sized.

The model I made in wood—many thanks are due to Mr. Swift, who has most patiently rendered it into that, in which, modest man though he be, he confessedly excels, viz., *brass*.

A view of the arrangement will make the plan clearer than any description can do. But I will call attention to one or two points which might escape notice on a first inspection.

1. The condenser is formed of two lenses, and besides acting as an ordinary condenser, makes a capital long focus dissecting lens.

2. The mirror is removable, and can be utilized as a side reflector above the stage.

3. The achromatic condenser, fitted with stops, giving a good black-ground effect, works by a milled head *above* the stage, and conveniently near the other adjustments.

4. The rest for the hands while dissecting which the stand gives is equally available when the binocular is being used for general observation. It is comfortable, and I hope will be found to increase delicacy in the manipulation of objects.

Though rigid, the stand can be made lighter than can that of the ordinary form.

I take it that the whole apparatus will not be more weighty than an ordinary binocular instrument; while it will, with all the helps to dissection, mounting, and observation, pack in a space not larger than ordinary small monocular instruments.

A larger number of cements could be carried if the bottles were of a slightly smaller size.

I should propose that, instead of the outside case being of polished mahogany, it should be of painted canvas, such as portmanteaus are made of.

The above was specially constructed for travelling, but might perhaps be useful to workers, as comprising in a small compass many things necessary for microscopical work.

THE PRESIDENT'S ADDRESS.

Delivered at the Annual General Meeting, July 28th, 1882.

By T. Charters White, M.R.C.S., L.D.S., &c.

It is again my duty to offer you my warmest congratulations on the continued prosperity of the Quekett Microscopical Club, as illustrated by the satisfactory Report just read. It must always be pleasing to those so intimately connected with its progress as now surround me to contemplate this prosperity, and the ever-increasing prestige which the Club holds in the estimation of the microscopical public; a prestige which is richly deserved by the stimulus and encouragement it has given to microscopical pursuits, especially amongst the younger members of the community; during the period of its existence—as from a centre, its influence has radiated to the provinces and even to our colonial possessions, and every member passing from its vicinity to other and distant localities has become a fresh centre of influence in exciting interest in microscopical observation. Should any future history of the microscope be written, we may certainly expect, without any wish to depreciate the work of other and kindred societies, that the important part which our Club has played during the 17 years of its existence, will find a ready recognition at the hands of the historian; and if we cannot point to so much good and original work as we could have wished, and the absence of which we regret, still the Club has fostered and encouraged that love of microscopical observation which may yet culminate in most valuable results when the occasion arises which demands them. There are very few young minds that are not at once struck with an intense interest in peering into the minute world revealed in the microscope; no voyager in strange lands can be more fascinated by the fresh and wondrous sights which arrest his attention than is the novice in microscopical observation with the innumerable forms of beauty, symmetry and grace which lay in the microcosm at his very feet. This intense interest leads him on with a burning desire to know more; we seem to hear the ringing

cry of "Excelsior" high up in the air; objectives which formerly were sources of satisfaction are now no longer sufficiently powerful; higher and still higher powers are demanded till the limits of illumination forbid his further advance, but still the longing desire to see more and farther into the invisible is unsatisfied, and in our present stage of progress ever will be.

To gain some insight into the magnitude and universality of this interest, we have only to look back over past ages to the early dawn of the science of optics, when the refrangibility of the light rays first arrested the observation of mankind, and then, tracing up the successive steps by which men sought to understand the various phenomena presented to their notice, we shall find that the desire for further information in this direction led to further investigations. Men were not satisfied by the bare glimpses revealed, as it were, through chinks and crevices, they longed to burst open the vast and wondrous storehouse which, by deductive reasoning, they felt lay beyond, and so they laid fact to fact, till law after law was eliminated from the hitherto unknown.

It is my wish this evening to endeavour to trace, shortly and briefly, because of the shortness of the time that can be allotted to me, some of the successive steps by which we have attained to our present position in the use of the microscope.

In our endeavours to trace the history of Optics back to remote times, we are met by much obscurity and no small difficulty in extricating ourselves out of a great deal that is uncertain, and our perplexity is not diminished by the considerable difference of opinion prevalent amongst the ablest critics relative to the first observers of that wonderful mode of motion upon which all our microscopical studies are based, and which we call Light. We shall readily concede that the earliest inhabitants of the earth were cognisant of the contrasts of light and shade, but beyond that point their observations did not probably extend. Then we read in history of the Chaldeans, Egyptians, and Chinese who, in early days, were acute astronomers, but we are not warranted in believing that they knew anything of the science of Optics, and certainly did not possess astronomical glasses; and although their observations were very accurate with such means as they did possess, it remained for successive generations to work out the laws of Light, which work has culminated in the finished and elaborate apparatus of to-day. In dealing with this subject we cannot overlook the im-

portance attached to that study of Light and the laws of refraction which forms the very foundation-stone on which microscopical science has been reared. Time will not, however, permit us to refer by name to all those early workers who helped to forward our knowledge of the subtle element, but it is sufficient to say that when once the ball was set rolling, by attention being called to the wondrous phenomena associated with Light, it attracted to its study all the ablest philosophers of ancient times, each in turn taking up the marvellous theme, and handing it on, with the additions received at his hands, to be still further elucidated at the hands of others; thus our knowledge of Light has increased from one step to another since Aristotle first laid the foundation of Optical Science, 2,200 years ago. Men in these early days were striving after this knowledge, and theories became abundant; thus we find it recorded in the history of this time that Empedocles, 450 B.C., held the opinion that Light consisted of particles emitted from luminous bodies, yet vision was not complete without certain emanations from the eye to the object. Aristotle, 100 years afterwards, called in question this theory, contending that light did not consist of material particles, but was rather an impulse propagated through some immaterial medium; his teaching, however, is so mixed up with mysticism that one cannot quite determine whether this may or not be considered as the first dawning of the wave theory of Light, which received its more perfect development under the hands of Newton and subsequent scientists. We find that the manufacture of glass had made considerable progress about this period, 450 B.C., and the mention of burning glasses by Aristophanes in his comedy of "The Clouds," written about 431 B.C., together with the statement that the Roman fleet before Syracuse, 250, B.C., was burned by Archimides by polished metal specula, although as an historical and physical fact open to grave question, yet testifies to the attention of early observers being directed to the refrangibility of the light-rays and their capability of being concentrated in a focus. Although this capability was known, very little practical use was made of it till after the Christian era. Seneca, about A.D. 50, observed the magnifying power possessed by glass globes of water, and Pliny, A.D. 79, describes surgical operations, probably actual cautery, being performed by means of spheres of rock crystal, and he also notices the fact that the rays of the sun coming through a glass globe filled with water, become a source of sufficient

heat to ignite any inflammable body on which they fall, but this power was not connected in the minds of these men with the lenticular form of the glass. Nevertheless every fact observed created one more link in that chain of our knowledge which spans the wide interval we are considering, and must not be passed by without notice. We are still, to a great extent, dealing with an age when speculation was rife, and demonstration had not began; theory was preceding practice, but Seneca proclaimed in prophetic tones, "The time will come when a future day, and the diligence of a distant age shall bring to light those things which now lie hid; the time will come when our posterity will wonder that we should have been ignorant of things so obvious." But that time is not yet reached in this review of microscopical progress. Claudius Ptolomæus, commonly called Ptolemy, about A.D. 140, finding that his astronomical pursuits necessitated a more accurate knowledge of the laws governing the refrangibility of the light-rays, set himself the task of working out the refractive indices of a ray passing at different angles from air into water or glass, being led to these calculations by observing that a coin placed at the bottom of a basin in such a position as to be invisible, became visible on pouring in water. He leaves behind him an elaborate collection of these measurements, which furnish the oldest extant example of accurately-conducted physical investigation by experiment.

A wide gap now intervenes between the researches of Ptolemy and the revival of the subject of magnifying glasses by Alhazen in 1100; during this period the subject of Light appears to have lain dormant, but we are getting more into the region of practical optics, for Alhazen observed that objects were magnified when held close to the *plane* side of the large segment of a sphere of glass. If during this period the practice of optics, if we may so call it, produced no evident result, yet the progress of our knowledge was not stayed, being helped in an eminent degree by the mathematical labours of Euclid, who gained for us a basis of definite calculation which served to forward our knowledge of the proper construction of lenses.

We know of nothing approaching the character of a lens existing at this period excepting that found by Mr. Layard in his excavations at the south-west Palace of Nimroud. As some stress may be laid upon this as proof that some sorts of magnifying glasses were in vogue in the ages of antiquity, I may describe it here, and I

think all who are competent to judge will discern that, whatever its use might have been, it could have been of but slight utility in enabling its possessor to amplify small objects. Sir David Brewster, to whom Mr. Layard submitted it, thus describes it:—"This lens is plano-convex, and of a slightly oval form, its length is $1\frac{6}{10}$ inches, and its breadth, $1\frac{4}{10}$ inches; it is about $\frac{9}{10}$ of an inch thick, and a little thicker at one side than the other; its plane surface is pretty even, though ill-polished and scratched; its convex surface has not been ground or polished on a spherical concave disc, but has been fashioned on a lapidary's wheel, or by some method equally rude. The convex side is tolerably well polished, and though uneven, from the mode in which it has been ground, it gives a tolerably distinct focus at $4\frac{1}{2}$ inches distance from the plane side. It is obvious from the shape and rude cutting of the lens that it could not have been intended as an ornament; we are entitled, therefore, to consider it as intended to be used as a lens, either for magnifying or for concentrating the rays of the sun, which it does however very imperfectly."

This lens was found in the Royal Palace of Nimroud, buried beneath a heap of fragments of blue, opaque glass (?) apparently the enamel of some object in ivory or wood, but it was honoured by being in the same room as the royal throne, and may now be seen by any one interested in this subject in the Assyrian collection at the British Museum, in a glass table case, supported in an upright position by wire standards. We may probably date the construction of this lens back to the time of Ninus and his wife Semiramis, for it was only in their reign that much encouragement was given to the arts, and that period would be about 2,000 years before the Christian era; thus entitling it to be considered the oldest lens extant, if lens it be. It is not of glass but of rock crystal.

Passing from this digression, we arrive at the early part of the 13th century, where we find Friar Roger Bacon hard at work in his laboratory at Oxford, applying his mathematical attainments to the construction of such lenses as were suitable for improving the sight, or, if not actually constructing them, laying down such rules for doing so as to prove that he was sufficiently master of the laws of refraction to be able to calculate the foci of segments of spheres, and thus aiding their adaptation to the construction of spectacles; but even in these comparatively modern times we are met by much obscurity in the history of lenses, some writers deny-

ing that Bacon possessed any especial knowledge of this subject, while others affirm that if he did not himself reduce his attainments to the actual formation and use of lenses, he made known principles which could hardly remain long without practical application. Some historians set down the year 1313 as the period when spectacles were first invented, but in 1299 we find one writer saying, "I find myself so pressed by age that I can neither read nor write without those glasses they call spectacles, *lately* invented, to the great advantage of poor old men when their sight grows weak." Some authors set down the year 1214 as that in which Friar Bacon invented spectacles, but leaving these doubtful points, you will see how from this time a steady onward progress is made in the application of the laws of Optics to the amplification of distant and small objects. From the death of Friar Bacon, in 1292, to the time of Maurolycus, about 1575, philosophers seemed to have been principally occupied in investigating the laws of refraction in their relations to glass and water, apparently repeating and verifying the observations and calculations of Ptolemy. Franciscus Maurolycus, an eminent mathematician of the 16th century, had advanced so far as to conceive the true office of the crystalline lens of the eye, and published his views in a work entitled "Theoremata de Lumine et Umbra," in which he gives an explanation of the facts noticed years before by Aristotle, that the rays from the sun passing into a dark room through a minute hole always gave an image of the sun on a screen placed at some little distance from it. About 15 years before the publication of this work, Baptista Porta, then a youth, invented the camera obscura, and Maurolycus being aware of the lens placed to concentrate the light in this camera, was led to consider the office of the crystalline lens to be analogous to it. All these instances I have quoted show that men's minds were actively exercised upon the subject of the refrangibility of the light-rays, and were led gradually to the evolution of more complex apparatus for the display of their phenomena.

Those of you who visited the exhibition of scientific instruments at the Loan Collection at South Kensington in 1876 may probably remember Galileo's telescope. Galileo was born A.D. 1564, and may be considered the founder of the microscope, inasmuch as after inventing the telescope the invention of the microscope was easy, the mathematical principles involved in their construction

being identical, and thus we find it recorded of Galileo that he constructed instruments for the magnification of small objects in 1612. He did not care so much for these as he did for his telescope and the glorious field of astronomical discovery it had opened up to him, and so his right to be considered the inventor of the two instruments has been overshadowed by the working opticians of that period.

The invention of the telescope appears to be variously ascribed to several others, and its history and origin consequently obscured. Thus it was attributed to one James Metius, who used to make burning glasses and mirrors, and who, casually looking through two of his lenses at a time, noticed that distant objects were brought apparently near. Other writers assign the discovery to John Lippersheim, or Lipperhay, of Middleburg, in Zealand; while Borellus gives the credit to Zacharias Jansen, another maker of spectacles of the same place, who it is stated made the first telescope in 1590. Several claimants, however, arose and asserted their rights to be called inventors, such as Francis Fontana, an Italian, who claims to have made a telescope in 1608, but it is well known that they were publicly sold in Holland long before that date. Some say that Galileo ought to be considered the inventor, but he himself disclaims any right to be so considered. His own account of the invention of the telescope is that hearing of some such contrivance, from rumours floating about, he set himself to consider upon what optical principles such an effect could be produced, and at length constructed a telescope, which showed distant objects magnified and erect, while the alleged discoveries of either Jansen or Lipperhay showed inverted images. Galileo would probably be about 30 years of age at this time, and, perhaps, making himself acquainted with all the scientific doings of the period, and hearing of the telescopes but not seeing them, would construct one on his own principles, and thus become a discoverer equally with the Dutch opticians. About this time much interest appears to have been taken in the effects produced by varying the position of lenses and by an alteration in their curvature, and thus the invention of microscopes followed very quickly on that of telescopes; and, according to Borellus, Zacharias Jansen again comes to the front with a composite form, something between a telescope and a microscope. The invention of microscopes has been claimed by Signor Fontana, who seems to have laid claim to

this invention in much the same fashion as he did to that of the telescope, for he never published any account of his invention till 1646, notwithstanding his assertion that he made the discovery a quarter of a century before. We may fairly disregard his claim in the undoubted fact that one of Jansen's microscopes which had been presented to Prince Maurice was in the possession of Cornelius Drebell, who, in 1617, resided in London, as mathematician to King James VI. Eustace Divini, about this period, made microscopes with two object glasses, as they were then called, and two plano-convex eye glasses joined together on their convex sides, enclosing them in a tube as large as a man's leg, the eye-pieces being of the size of the palm of the hand; but opticians were all at sea in their conceptions of microscopical requirements, and hence this clumsy and unwieldly tube of Divini's, for we find that about 1688 Hartsoeker, by means of a single lens of high curvature, made such investigations that he laid the foundation for our true knowledge of the function of reproduction; and those of you who have any acquaintance with physiology will readily understand that the minute single lenses he employed mnst have possessed great magnifying power and a not very imperfect definition. The combination of these qualities rendered them so suitable for the amplification of small objects that books treating of microscopes, published about this time, contain directions for the production of these lenses by melting threads of glass in the flame of a candle till the glass runs into a spherical drop. Christian Huygens, an eminent Dutch mathematician and astronomer, about 1678, had made such a simple microscope as this, the $\frac{1}{10}$th of an inch in diameter, which gave a linear magnifying power of 100, and doubtless this was considered an achievement in those days; and except for the difficulty of applying objects to it, the want of light, and the contracted field, it might be considered a very perfect instrument for that time. It was with such a microscope that Leeuwenhoek made all those marvellous discoveries of infusorian life which will immortalise his name wherever the microscope is used. He employed double convex lenses of various diameters, which he made for himself by melting rods of glass in a flame and afterwards grinding them to the desired curvature. Twenty-six of these microscopes, together with the apparatus which held them, he bequeathed to our Royal Society. The greatest magnifying power amongst them has its focus at $\frac{1}{20}$ of an inch from the object, and is said to magnify 160

diameters. In 1710 Mr. Adams gave to the Royal Society a paper detailing his method of making these microscopes, and he states that placing these globules of glass between silver plates, having holes in them to hold the lenses, he found them act admirably. It soon occurred to others that if spherical drops of glass would magnify, spherical drops of water would do so also; and a Mr. Stephen Gray published a paper, in which he gave the necessary directions for the formation of microscopes from drops of water held in suspension from pin holes in plates of metal; but it was found that the refractive power of water was not so great as that of glass, and consequently these water lenses were abandoned, but subsequent investigators, amongst whom we may name Sir David Brewster, still tried fluid lenses, substituting viscid fluids of different degrees of density for the plain water formerly used, and generally with good results, but they were not found so convenient in their manipulation as more solid material, and they were finally abandoned. Opticians then, a few years after, ran to the opposite extreme, from fluids to the hardest known materials; and we find it recorded that Messrs. Goring and Pritchard made lenses of diamonds, sapphires and garnets, but the expense of working these, and certain faults found in the diamond lenses after they were fashioned into shape led to the discontinuance of their use. The smallest globules of glass, and therefore the greatest magnifying powers in existence in 1765, were made by Signor Torre, of Naples, who sent four of them to the Royal Society; the largest of them being only $\frac{1}{36}$th of an inch in diameter, but said to magnify the diameter of an object 640 times. The smallest was $\frac{1}{144}$th of an inch. Whatever use Torre made of these is not stated, but Baker, who had successfully worked with Leeuwenhoek's glasses, could make nothing of them. Up to this period history affords us very little insight into the mechanical arrangements of microscopes, for with the exception of the plates used to hold these glass spheres, with a point upon which to place the object in their focus, we hear of nothing besides until we come to 1743, when the microscope most generally known and used was Wilson's pocket microscope, and as its appearance, after the simple lens and its sustaining plate, must have excited some wonder and admiration I may briefly describe its character. Its body was of brass, ivory, or silver. The single lens doing duty as eye-piece was fastened in the end of a tube, which, having a finely threaded male screw cut on its outside and

working within the female screw cut in the body of the instrument, served to get the focus, the various magnifying powers being screwed into the end of the body. A handle, fastened by a screw to the outside of this tube, served to hold this microscope up to the light in examining an object. This, after all previous contrivances, was deemed a great advancement in adaptation of focus and convenience of application to objects; but soon the inventive genius of that day found means for its improvement, and it was followed by the single reflecting microscope, for it was found to be inconvenient to hold Wilson's microscope up to the influence of direct light; therefore a modified arrangement of it was supported by a vertical scroll fixed in a circular wooden foot, and a mirror mounted beneath, so arranged that light from any source could be directed into the body of the microscope. We have here, in this instance, the first practical inception of our present arrangements, and although this was considered another step in advance of Wilson it did not satisfy the growing needs of microscopists of that day, inasmuch as it could only be used for transparent objects, and they needed sometimes to look at those which were opaque, and condensing lenses were then added to this form of microscope. Culpepper, and after him Cuff, still further improved upon this, till a great advance towards our present form was made by Benjamin Martin in an instrument designed to serve the combined uses of what at that time were divided into single, compound, opaque, and aquatic microscopes. It would be tedious were I to enlarge upon the progressive stages by which our grand instruments of to-day have been undergoing a gradual process of evolution from the primitive and ere-while considered perfect instrument of 140 years ago, and therefore I must omit what is so well known to all present.

Although the principle of binocular vision was applied to telescopes by John Lippersheim for the Dutch government in 1609, it was not till 1667 that it was applied to the microscope by Père-Chérubin, of Orleans. Although the clever friar was so successful that the effects were stated to be marvellous and surprising, yet the discovery laid dormant till Sir Charles Wheatstone directed the attention of the scientific public to his stereoscope, and, calling in the aid of our distinguished opticians, Messrs. Powell and Ross, tried to construct a microscope on stereoscopic principles; but practical difficulties opposed further progress in this direction.

In 1851 the difficulty was solved by Professor Riddle, of the

United States, and a binocular microscope was constructed and figured in "Silliman's Journal" for 1853. Nachet also, as you are aware, was highly successful as a maker of this form of instrument, and our fellow countryman, Mr. Wenham, made such further important improvements that this class of instrument is still held in the greatest estimation by those microscopists who do not need the very highest powers objectives can furnish. In the binoculars in general use the images are, as you all know, inverted, but a notice of this kind, which endeavours to treat of the progressive advancement of our favourite instrument, cannot be allowed to omit the mention of that form of binocular invented by Mr. J. W. Stephenson, wherein the images are erect, and increased facilities are thereby given for the easy exploration of minute structures even with very high powers. Now, in looking back over that period of time embraced by these few notes, we are enabled to estimate the amount of interest which has actuated the minds of men in striving after a more perfect knowledge of the nature of Light and its various phenomena; and it is worthy of notice that an interest born in the dark ages of antiquity, and fading not through mediæval times, exists in its greatest intensity in the present, and who can tell what the future may produce? As the laws of Light became better understood, so our means of seeking the invisible became gradually more perfect, till the limits of our illuminating power forbade the use of objectives higher than Powell's $\frac{1}{80}$, but who shall presume to assert that, with the advent of the electric light and improved immersion fluids, we shall not be able to extend our vision into that world which we know lies beyond the grasp of our present powers. It is but 140 years since the first birth of Wilson's microscope—the crude and early parent of our present form—and what is that length of time wherein to perfect our microscopical appliances? I doubt not but it will be considered too brief for much development, a period of adolescence in the long life of the microscope, but a period long enough, it is true, to bring it from a plain and primitive form to one in which, by the combined endeavours of home and foreign scientists, it presents a grand piece of mechanism contrived for every conceivable purpose. I should be sorry to think we had attained the utmost limits of our power of reaching further into the, at present, invisible world which lies beyond the grasp of our $\frac{1}{80}$ of an inch objective, and which that barely touches; but if so much has been

attained in the comparatively short time we have been considering, I think we have great and abundant cause for hope in the years to come. Through the ages all along the subject of Light has been one of surpassing interest to the minds of men, an interest which even at the present time stimulates the students of physical science to unravel the intricacies of refraction, diffraction, polarization, spectrum analysis, photography, and other cognate branches of this intensely interesting element, and where all are so urgently investigating, I feel we, as microscopists, are encourged to look forward to many and great improvements in our favourite instrument, enabling us to see definitely and distinctly much that at present is hidden from us.

In this necessarily condensed and hurried review I have endeavoured to carry your minds back to the simple bead of glass, to show you that when once the interest in the amplification of small objects took possession of the minds of men they became dissatisfied with the powers at their disposal, and sought for increased facilities. And do we find the microscopical mind any more satisfied now than in the days of the simple bead? We have made long strides beyond that day of small beginnings, but our longings are still unmet. We are still longing to pierce the infinitely invisible; and doubtless, in process of time, we may be furnished with such improved and increased powers as shall exceed our present microscopes as much as they surpass the simple sphere of glass. Humanity owes much to the microscope, for it has been a messenger of many blessings to the great human family, not only in furnishing a lofty and soul-raising recreation, but in being the means of assisting us to many an insight into the great problems of life. In this aspect alone the microscope calls for the devoted labours of all who make the subject of Light their great study, to enable it to show those hidden causes of death and disease which spread sorrow and distress throughout the land, and possibly help us to a solution of the many difficulties which beset the path of the pathologist. All glory, I say, be to those workers of whom Prof. Abbe is a type. It is to the results of their labours that the future microscopists must look for further advances. Workers in the early days fashioned their lenses by the rule of thumb: now the rigid laws of refraction are made to yield beneath the will of modern science, and who is bold enough to limit its power?

I beg now to thank you heartily for the honour you have con-

ferred upon me in electing me as your President. If in fulfilling the duties of that office I have given satisfaction, I must attribute it to your kindness in overlooking that inefficiency of which I am only too conscious, and which I have many times regretted. Gentlemen, I now take my leave of you in that capacity by introducing my successor in the person of an old and well-tried friend of our Club, Dr. M. C. Cooke.

Report of the Committee.

July 28, 1882.

Your Committee, in presenting the Seventeenth Annual Report, feel bound to record that the past year, though not devoid of good work, has been characterized by an absence of general activity, for which it is difficult to account.

The number of our members still keeps up to the average of the last few years. We have, however, to regret the loss by death of four members, Mr. W. Atkinson, Mr. W. W. Hewitt, the Rev. W. M. Hutton, and Mr. W. Moginie.

Two of these gentlemen came but little amongst us, but Mr. Hewitt was well known to many of us in former years, principally by his long connection with the late Mr. Andrew and Mr. Thomas Ross. Mr. Moginie was one of our early members, and was much esteemed, both for his amiability and genial manners, and for the great mechanical skill with which he devised many microscopical and other appliances.

The resignation of 17 members, the erasure of 7 for failure in payment of several years' subscription, and the election of 31 new members, leaves our present number 616.

The papers read at our meetings have been unusually few. The following is a list :—

1881.

Aug. 26. "On Fluid Cavities in Meteorites," by Mr. Heinrich Hensoldt.

Sept. 23. "On the Injection of Specimens for Microscopical Examination," by the President.

Nov. 25. "On the Structure and Division of the Vegetable Cell," by Mr. W. H. Gilburt.

Dec. 27. "On an Improved Compressorium," by Mr. J. D. Hardy.

1882.

Jan. 27. "On Sand," by Mr. J. G. Waller.

Feb. 24. "On the Histological Development of the Larva of *Corethra plumicornis*," by the President.

Mar. 24. "On Fishes' Tails," by Mr. E. T. Newton.

April 28. "On an Algal form growing in a solution of Sulphate of Copper," by Mr. F. Kitton.

May 25. "On a new form of portable Microscope," by the Rev. H. J. Fase.

The various verbal communications have been the means of affording information upon many subjects of interest. They will be found reported in the Proceedings.

The difficulty of obtaining original papers continues to increase; and it is for those members who have at heart the welfare of the Club to consider what claim it may have upon them to be the channel for the publication of their investigations, and to what extent they can further its interests in this respect. It by no means follows that the results of their observations are not worthy of record, because they may not involve any discoveries that are positively new. Confirmation of the work of previous observers may often prove as valuable as a new discovery.

Your Committee have been able to make considerable additions to the Library, which has now become really valuable for reference on subjects connected with microscopy. The following is a list of the additions :—

	Presented by
"Dr. Carpenter on the Microscope." 6th Edition	The Author.
"Marsh on Section Cutting"	Mr. F. Wood.
"Balfour's Comparative Embryology." Vol. 2	Mr. T. Charters White.
"Tyndall's Floating-matter of the Air" ...	Mr. J. W. Groves.
"Dr. Braithwaite's British Moss-Flora." Parts 1-5	The Author.
"Smithsonian Institution Report, 1880" ...	U.S. Government.
"Transactions of the Linnean Society." 5 Vols.	Mr. F. Crisp.
"Journal of the Linnean Society." 2 Vols.	Mr. T. Charters White.
"Proceedings of the Royal Society" ...	The Society.
"Journal of the Royal Microscopical Society"	" "

"Popular Science Review"	The Publisher.
"Hardwicke's Science Gossip"	" "
"Handbook of the Wild Silks of India" ...	H.M. Government.
"Northern Microscopist"	In Exchange.
"American Naturalist"...	"
"American Monthly Microscopical Journal"	"
"Reports of H.M.S. Challenger Expedition." Vols. 3-4	Purchased.
"Hitchcock's Synopsis of Leidy's Freshwater Rhizopods of North America"	"
"Davis' Practical Microscopy"	"
"Botanical and Physiological Memoirs" (Ray Society)	"
"Catalogue of the Histological Series in the Museum of the College of Surgeons." 2 Vols.	"
"Catalogue of the British Bees in the British Museum"	"
"Haeckel's Radiolarians." 2 Vols. ...	"
"Darwin's Monograph of the Cirripedes." 2 Vols.	"
"Gosse's Sea Anemones"	"
"Gosse's Manual of the Marine Zoology of the British Isles.' 2 Vols....	"
"Picard's Spiders of Dorset." 2 Vols. ...	"
"Jeffrey's British Conchology." 5 Vols. ...	"
"Spottiswoode's Polarization of Light" ...	"
"Dillwyn's British Confervæ"	"
"Hooker and Baker's Synopsis Filicum" ...	"
"Dr. Braithwaite's British Sphagnaceæ" ...	"
"Piaget's Les Pédiculines." 2 Vols. ...	"
"Biasoletto on Algæ"	"
"Rabenhorst's European Algæ." 3 Vols. ...	"
"Bornet and Thuret's Notes Algologiques"	"
"Wood's Freshwater Algæ of North America"	"
"Matthew's Trichopterygia"	"
"Milne Edwards on Annelids." 2 Vols. ...	"
"Thomé's Structural Botany"	"
"Schmidt's Atlas of the Diatomaceæ." Parts 17-20	"
"Van Heurck's Belgian Diatoms." Parts 4-5...	"
"W. Saville Kent's Infusoria." Parts 4-6 ...	"
"Micrographic Dictionary.' Parts 1-12 ...	"
"Annals of Natural History"	"
"Quarterly Journal of Microscopical Science"	"

"Grevillea"	Purchased
"Dr. Cooke's British Freshwater Algæ." Parts 1-2	"

Reports and Proceedings of various Societies and Sundry Pamphlets.

A new catalogue of the Library will shortly be issued.

The following donations have been made to the Cabinet :—

By the President...	20	Slides.
" Mr. H. E. Freeman	5	"
" Mr. J. W. Groves	1	"
" Mr. H. F. Hailes	6	"
" the Rev. J. J. Halley, of Victoria, by Mr. T. Curties	16	"
" Mr. G. Paton	1	"
" Mr. B. W. Priest	2	"
" Mr. C. V. Smith	6	"
" Mr. W. D. Smith	6	"
Total	63	

It has been considered advisable to close the first series of the Journal with the sixth volume, comprising the proceedings of the Club for sixteen years. Mr. Alpheus Smith has added to the value of this series, by compiling a copious general index ; and your Committee take this opportunity of thanking him for this gratuitous addition to his other honorary services.

The Excursions during the past year have been on the whole well attended and productive, the weather in most instances having been favourable. It is satisfactory to note that this important feature in the practical work of the Club has not been neglected.

An idea of the value to microscopists of some of the localities visited may be formed by reference to the list furnished by Mr. W. G. Cocks, and published in the Journal, of the various specimens found at the recent excursion to Snaresbrook ; and the importance of such public spaces being preserved in their natural condition, is now fully recognised.

The attendances at the meetings have been unusually small, and apparently confined for the most part to those engaged in active work. This is due no doubt in a great measure to the rival claims of local societies, many of which have now attained great efficiency. It is to be regretted that more interest is not taken in the proceedings of the Club by a larger number of the general body of the

members; but your Committee cannot imagine that a circumstance of this kind is permanent in its character.

Your Committee, bearing in mind the great expense attendant upon a Soirée, have not felt justified in holding one during the past year.

Your Committee have considered it advisable to invest the sum of £40 out of the subscriptions in view of future contingencies; and they propose to make similar investments from time to time as circumstances permit.

A Special Exhibition Meeting was, by the kind permission of the College, held on the 31st of March, and was quite as successful as that held in the preceding year. Fewer invitations were issued, in order to avoid the overcrowding previously complained of, but the attendance of members and visitors was very satisfactory, and the objects exhibited were numerous and interesting, and of a kind well calculated to keep up the prestige of the Club in this respect.

The Club has again to thank the Committee of Management of University College for their kindness in renewing permission to hold the Club meetings in the College for the ensuing session, and for the assurance that the friendly relations between them remain unaltered.

Your Committee beg to thank the Officers of the Club for their honorary services during the past year, well knowing how much of its success is due to their efficiency.

Having regard to the great increase in the resources of the Club made during the last few years, your Committee hope that the members will hereafter avail themselves to a greater extent of the advantages of obtaining instruction and information offered by its present efficient condition, and by the social and friendly intercourse that characterizes it.

TREASURER'S STATEMENT OF ACCOUNT.

Dr.

June 30, 1882.	£	s.	d.
To Balance in hand, July 1, 1881	174	10	10
Subscriptions received	240	0	0
Compounding Subscription to invest	10	0	0
Dividends on Compounding Subscriptions ...	2	7	1
Sale of Journals	8	15	2
	£435	13	1

Cr.

June 30, 1882.	£	s.	d.
By Printing and Stationery	27	10	6
Postage, Carriage, &c.	7	19	2
Attendance, Lighting, and College Expenses ...	23	0	0
Subscriptions Invested	40	0	0
Compounding Subscription do.	10	0	0
Property Purchased	48	13	1
Journal	156	10	11
Expenses of Special Exhibition Meeting	12	13	2
Petty Expenses	0	13	7
Balance in hand	108	12	8
	£435	13	1

Amount invested in New 3 per Cent. Annuities, £100.

We, the undersigned, having examined the above Statement of Income and Expenditure, and the vouchers relating thereto, hereby certify the same to be correct.

Wm. HAINWORTH,
H. H. DOBSON, } Auditors.

July 11th, 1882.

PROCEEDINGS.

March 31, 1882.—Special Exhibition Meeting.

By the kind permission of the College, a Special Meeting for the exhibition of interesting Microscopical Objects was held in the Library, and proved quite as successful as that held on the 29th April, 1881. The number of visitors was not so great, as it had been found necessary to issue fewer invitations in order to avoid overcrowding. They, however, amounted to about 180, while the members numbered over 200. The exhibits were numerous and interesting, nearly 80 microscopes being brought.

The following is a list of such of the objects as were described on the exhibitors' cards :—

Larval condition of *Corethra plumicornis*, shown in a new growing slide ...	The President.
Genuine Antique Roman glass, showing the laminæ, &c.	Mr. F. W. Andrew.
Isthmia enervis, in situ	Mr. W. A. Bevington.
Heliopelta metii	Mr. W. R. Browne.
Arachnoidiscus japonica	,, ,,
Callithamnion tetricum, marine alga, in fruit...	Mr. T. H. Buffham.
Hydra vulgaris	Mr. E. Carr.
Polyxenes lagurus	Mr. W. G. Cocks.
Volvox globator	,, ,,
Anthrenus (Tree *Dermestes*)	,, ,,
Leaf of *Drosera rotundifolia*, stained	Mr. F. Coles.
Scalariform tissue, root of fern	Mr A. L. Corbett.
Pleurosigma angulatum ($\frac{1}{6}$ in. objective) ...	Mr. H. Crouch.
Seed of *Nemesia versicolor*	,, ,,
Bowerbankia, Marine Polyzoon...	Mr. E. Dadswell.
Nitella, in fruit	,, ,,
Objects Multiplied by Eye of *Dytiscus* ($\frac{1}{5}$ in. obj.)	Mr. A. Dean.
Arachnoidiscus ornatus on Coralline	Mr. C. G. Dunning.
Head of Hornet, *Vespa crabro*, prepared without pressure	Mr. F. Enock.
Ship's Barnacles removed from the shells to show tentacles and intestine ...	Mr. H. Epps.
Section of eye of *Dytiscus latissimus*, polarized	,, ,,
Recent *Foraminifera*, 100 species, arranged...	Mr. J. Epps, Jun.
Scales of Death's Head Moth	Mr. A. Fieldwick, Jun.
Grouped Diatoms	,, ,,

Mouth of *Balanus*, the Acorn shell	Mr. F. Fitch.
Exuvium of *Cercopsis*, a plant bug	Mr. H. E. Freeman.
Asterma gibbosa, a week old	" "
Vorticella, &c., from an Aquarium	Mr. G. H. Fryer.
Insects in Amber	" "
Sponge spicules	" "
An old Microscope and apparatus	" "
Entomostraca	Mr. F. W. Gay.
Argulus foliaceus	" "
Arrenurus globator	Mr. C. F. George.
" *sinuator*	" "
Cyclosis in *Anacharis alsinastrum*	Mr. H. R. Gregory.
Horny upper lips of edible snail, *Helix pomatia*	Mr. J. W. Groves.
Penicillium glaucum, blue mould	" "
Hydra viridis and *H. fusca*	Mr. W. Goodwin.
Pycnogon—*Achelia hispida*	Mr. H. F. Hailes.
" *Pallene pygmæ*	" "
Stentors, Rotifers, *Volvox globator*	Mr. W. Hainworth.
Various dry-mounted objects shown by chromatic light	Mr. J. D. Hardy.
Section of Nephetine Dolomite...	Mr. G. Hind.
Hippocampus	" "
Actinophrys sol.	Mr. C. F. Holland.
Micrasterias rotata	" "
Bird Acari, mounted by the late Mr. J. Cocken	Mr. J. E. Ingpen.
Section of Monkey's tooth	Dr. W. T. King.
Head of Honey-bee	" "
Ova of *Gobius niger*	Mr. R. J. Larking.
Grouped Diatoms	" "
Gonium pectorale; Euglena	Mr. C. Le Pelley.
Campanularia on a Crab, and various Polyzoa	Dr. Matthews.
Split sections of Coral, *Distichopora*	" "
Diatomaceæ	Mr. G. A. Messenger.
Sphacelaria filacina, a British Seaweed, covered with *Anguinaria spatulata*, the "Snake's Head Coralline"	Mr. A. D. Michael.
Amphitetras ornata, 5 angled var.	Mr. H. Morland.
Surirella nobilis	" "
Bacillus anthracis in section of liver of Goat, stained with methyl violet	Mr. E. M. Nelson.
Transverse section of tooth of Wolf fish, *Anarrichus lupus*, showing labyrinthine structure	Mr. E. T. Newton.
Gizzard of Cricket	Mr. M. D. Northey.
Orthoseira arenarea	Mr. J. M. Offord.
Foot of *Dytiscus*	" "
Sponge, *Meyerina claviformis*	" "

Diatoms, *Arachnoidiscus ornatus*, in situ on Coralline	Mr. B. W. Priest.
Magnesium Platinocyanide	Mr. W. W. Reeves.
Germinated Spore of *Lycopodium denticulatum*	" "
Longitudinal and transverse sections of *Aristolochia ornithocephalus*, showing Tyloses...	Mr. J. W. Reed.
Sections of leaf, petiole and stem of *Passiflora lancifolia*	" "
Twelve slides illustrating the incubation of the Chick from the 18th hour to the 10th day	Mr. W. J. Scofield.
Hooks of *Tænia serratus*	Mr. W. Smart.
Nicothæ astaci, parasite of Lobster	" "
Sections of Echinus spines	Mr. Alpheus Smith.
Larva of *Echinus microtuberculatus*	" "
Lava from Etna (Augite, Dolerite)	Mr. G. J. Smith.
Diorite (?), South America	" "
Meteorite, United States, &c., &c.	" "
Larva of *Corethra plumicornis*...	Mr. J. Stocken.
Cristatella mucedo	" "
Volatilization and burning of Copper, Iron, Magnesium, and Zinc by electric arc	Mr. A. W. Stokes.
Section of small intestine of Turkey	Mr. J. W. Tate.
Section of lung of Frog, Injected	Mr. J. J. Vezey.
Analyzing crystals of Iodo-sulphate of Quinine; Crystals of Aconitina; Lactate of Copper; Kinic Acid	Mr. H. J. Waddington.
Sections of stems of *Ampelidea* and *Bignonia*...	Mr. F. H. Ward.
Skin from pad of Dog's foot, opaque injection...	Mr. W. D. Wickes.
Intestine of Jay, " " ...	" "
Foot of Spider	Mr. J. Willson.
Proboscis of Blow Fly	" "

The Museum was open, and received considerable attention from the members and visitors.

April 28th, 1882.—Ordinary Meeting.

T. Charters White, Esq., M.R.C.S., &c., President, in the Chair.

The minutes of the preceding meeting were read and confirmed.

The following additions to the Library were announced:—

"Proceedings of the Royal Society" ...	From the Society.
"Journal of the Linnean Society"	Mr. T. C. White.
"Proceedings of the Geologists' Association"	From the Association.
" " Natural History Society of Glasgow"	" Society.

"Annual Report of the Brighton and Sussex Natural History Society" ...	From the Society.
" " " Hackney Microscopical Society"	" "
"Bulletin of the Belgium Microscopical Society"	" "
"Science Gossip"	The Editor.
"The Analyst"	" "
"The Northern Microscopist"	" "
"Proceedings of the American Society of Microscopists"	The Society.
"The American Naturalist"	In exchange.
" " Monthly Microscopical Journal"	" "
"Bulletin of the American Museum of Natural History"	Canada Government Department.
"Report of progress of the Natural History Survey of Canada," and set of maps in illustration of the same	Canada Government Department.
"Quarterly Journal of Microscopical Science"	Purchased.
"Annals of Natural History"	"
"Micrographic Dictionary"	"
Dr. Cooke's "Fresh Water Algæ"	"

The thanks of the meeting were voted to the donors.

The President read a letter from Mr. Kitton, "On an Algal form growing in a Solution of Sulphate of Copper." The slide sent by Mr. Kitton had unfortunately been broken in the post, but enough remained to enable him to form an opinion that it was more of the nature of a fungus, such as was occasionally met with in this kind of Solution. He had frequently met with these fungoid growths, sometimes in places where they might have beenl east expected. Once he found some in a solution of Carbolic Acid in Glycerine; and at another time he found a large bottle of Liquor Arsenicalis to contain a great quantity.

Mr. E. T. Newton asked if the President examined the fungus to which he referred under the microscope, so as to assure himself that it was really a fungus, and not a deposit of the flocculent matter which was often seen in solutions? In the treatment of disease and of wounds very diluted carbolic acid was successfully used to destroy fungoid growths, and it seemed curious that they were found to grow freely in a concentrated solution.

Dr. Matthews said that formerly, for convenience in dispensing, he used to keep various salts in solution, but experience showed that none of them could be kept thus for any length of time, all of them developing mycelium. This was especially noticed to be the case with citric acid or tartaric acid, and compounds with alkalis. The only thing which seemed to resist the formation was alcohol.

Mr. Buffham said that a solution containing $\frac{1}{6}$ alcohol had been tried, but it did not prevent the evil; but he had tried a solution of oamphor in dis-

tilled water, and there was no mycelium in that after several years. He found, however, that it formed on the surface of a saturated solution of common salt.

Dr. Matthews said that at the time he alluded to he did not use distilled water, but any that was ready to hand.

Mr. Sigsworth said that camphor water had been found to preserve even a solution of citric acid.

Mr. Spencer thought that distilled water was not always to be relied upon, for Prof. Tyndall stated in his book on " Moving Matter in the Air," that he had found Bacteria in nearly all the distilled waters supplied to him by the chemists.

Mr. Hardy described a method of illuminating crystals and similar objects by coloured light, termed by him the " Chromatoscope."

Mr. Hainworth inquired if he correctly understood Mr. Hardy to say that all crystals to be viewed in this way must be mounted dry.

Mr. Hardy said this was so. It would not do to mount them in balsam.

Mr. Ingpen exhibited a series of diagrams which had been drawn for him by Mr. W. T. Suffolk to illustrate Professor Abbe's theory of the vision of minute objects by their diffraction spectra. They were very beautifully and correctly drawn in their proper proportions, as seen in the microscope.

Mr. Michael made some interesting remarks with reference to a slide which he exhibited in the room—one of the *Chalcididæ*—a class of insects which he described as being very remarkable on account of the extraordinary variations which existed amongst them, and for the wonderful persistence of their predatory instincts. Sketches on the black board were made in illustration of the curious development of the antennæ.

Dr. Matthews inquired if Mr. Michael had any suspicion as to the special function of this very curious organ.

Mr. Michael said he was scarcely able to say what its special use might be. The auditory organs were usually supposed to be in the antennæ, and probably were so, though perhaps nearer the base. He should suppose that this was more of a tactile organ, its development rendering it of use to the creature over a comparatively large area; the constant rapid play of the antennæ certainly gave the impression that they were tactile organs, and that probably they might be necessary to enable the insects to appreciate the vibrations by means of which they tracked their prey.

Mr. Ingpen said he had brought for exhibition a slide of *Volvox*, mounted in a dilute solution of iodide of potassium, which seemed to promise so well for the preservation of Volvox and Desmids, and such like things, that he should like some one else to try it. He could not tell the exact strength of the solution, but it was certainly weak; he believed it was about 5 grains to the ounce when mixed with the water containing the organisms, though it might be well to vary the strength according to the condition of the algæ to be treated. The slide which he had brought was of *Volvox*, in

the stage where it had orange spores, in which state it was extremely likely to be disintegrated; the green parts were untouched by the iodide, but the parts which had become orange were rendered more brilliant, and the preservation, as far as it had gone, seemed very good. The specific gravity of such a weak solution would be, as nearly as possible, the same as that of water.*

Mr. Michael inquired if Mr. Ingpen had any experience with other kinds of Algæ, such as *Closterium?* The two things easiest of all to preserve had hitherto been *Volvox* and *Micrasterias*, but he should be glad to know if this new medium had been tested with *Closterium.* There were some extremely fine foreign slides which showed *Volvox* very well indeed, but other kinds of Desmids were not so well preserved.

Dr. Matthews said that Dr. Cooke relied very much upon mounting these plants in plain water. Had Mr. Ingpen tried that plan?

Mr. Ingpen said he had mounted specimens of Desmids in plain water, but had never succeeded well—there had always been a great deal of shrinking. Dr. Cooke said truly that if they wanted to *name* Desmids they must get rid of the endochrome; but in this case he wanted to see and preserve the endochrome. The action upon *Closterium* would undoubtedly be greater than on *Volvox;* but then it varied very much in *Volvox.* If they got a sterile specimen they might find it unaltered for months afterwards, but if it were developing, that would be a very different matter. Another objection to plain water was that there always seemed to be some degree of alteration in the tissues, as if by a gradual death. To preserve these objects effectually they should be killed suddenly. He thought that the success of the process depended very much upon the exact stage in which the specimens happened to be.

Mr. Waddington said he did not find the quantity named strong enough to kill these objects. One thing, however, struck him, and that was how peculiarly refreshing it seemed to hear of so simple a solution after some of the heroic mixtures which had of late been recommended. He thought that the iodide should be as pure as possible, for he believed that in what was ordinarily sold it was usual to add some alkali.

Votes of thanks to those gentlemen who had made communications to the meeting were unanimously passed, and announcements of meetings and excursions for the ensuing month having been made, the meeting terminated with the usual Conversazione, at which the following objects were exhibited:—

Pappus of Lettuce seed	Mr. F. W. Andrew.
Desmids, &c., &c., a gathering from Keston ...	Mr. E. Dadswell.
Young Locust *Œdipoda cruciata*, one day old	Mr. F. Enock.
Amœba diffluens, &c., in a growing slide, showing different stages of development	Mr. W. Goodwin.
Stentors	Mr. H. R. Gregory.
Objects shown by coloured light (Chromatoscope)	Mr. J. D. Hardy.

* The success of this method is doubtful when there is much organic matter or iron in the water.—J. E. I.

Eulopus pectinicornis (Chalcididæ), with curiously branched Antennæ ...	Mr. A. D. Michael.
Longitudinal and transverse sections of stem of *Piper nigrum*	Mr. J. W. Reed.

Attendance—Members, 49; Visitors, 4.

May 12, 1882.—Conversational Meeting.

The following objects were exhibited :—

Section of Maize seed, showing Spiral fibre ...	Mr. F. W. Andrew.
Antheridia on *Callithamnion tetricum*, a Marine Alga	Mr. T. H. Buffham.
Hydrodictyon in very early stages; from Hampton Court	Mr. J. E. Ingpen.
Epistylis grandis	Mr. H. R. Gregory.
Chelymorpha phyllophorus, Maple Leaf-insect	Mr. H. Morland.
Longitudinal and transverse sections of *Urvillea ferruginea*	Mr. J. W. Reed.

Attendance—Members 39.

May 26th, 1882.—Ordinary Meeting.

T. Charters White, Esq., M.R.C.S., &c., President, in the Chair.

The minutes of the preceding meeting were read and confirmed.

The following gentlemen were balloted for and duly elected members of the Club:—Mr. Walter Chapman, Mr. H. Saxon Snell, jun., Mr Geo. Western.

The following donations, &c., were announced :—

"Proceedings of the Royal Society"	From the Society.
"Transactions of the Linnean Society," 3rd Series	Mr. F. Crisp.
"Journal of the Linnean Society"	Mr. T. C. White.
"24th Report of the East Kent Natural History Society"	The Society.
"Science Gossip"	The Publisher.
"The Northern Microscopist"...	" "
"American Monthly Microscopical Journal"...	In exchange.
"New Part of Van Heurck's Belgian Diatoms"	Purchased.
"Annals of Natural History"	"
"Grevillea"	"
Two Slides of *Arachnoidiscus*	Mr. Priest.

The thanks of the meeting were voted to the donors, and a special vote of thanks was accorded to Mr. Crisp for his valuable donation of the "Transactions of the Linnean Society," and for the promise to continue to present his set to the Club in the future.

The Secretary said that Mr. Sigsworth had asked him to bring before the notice of the members a small clip which he had found very useful for mounting and other purposes. It had a small curved steel spring screwed upon a piece of cedar, and was sold by stationers as a paper clip. It appeared to be more useful in many cases than the American clips, which had a want of parallelism. In reply to a question, Mr. Sigsworth stated that the article could be obtained from almost any stationer for a shilling per dozen.

The President said they were favoured by the presence of Dr. Ralph, President of the Victoria (Australia) Microscopical Society, and welcomed him cordially in the name of the Club.

The President said they had received a letter from the President of the Natal Microscopical Society, accompanied by some diatomaceous earth, which would be reported upon when it had been examined.

The President read a communication from the Rev. H. J. Fase, describing a new form of portable microscope, which was sent that evening for exhibition.

The Secretary exhibited the microscope, and explained its various features in detail.

The President said he was extremely pleased with this new instrument, and felt sure that when the members examined it after the meeting they would agree that it was quite a *multum in parvo*. One very useful arrangement was that which admitted of the condenser being used also as a dissecting lens.

Dr. Ralph, who was called upon by the President, expressed the pleasure which he felt at being present at a meeting of the Club. He had brought with him a specimen of *Vallisneria* of a species found in Victoria, which he thought it might be interesting to cultivate in this country. It grew freely in Sydney, and was altogether much larger than the English species. The leaves, when fully grown, attained a length of four or five feet, with a breadth of about an inch, whilst their thickness was so great that horizontal sections of the leaves could be cut, and the cyclosis seen in this way to great advantage. He had grown this plant in Australia, in the open air, in a window, and found it would stand a temperature of 100° without injury, but it would not bear the cold of winter in this country if exposed. He had much pleasure in presenting a specimen of the male plant to the Club. He believed that male plants were never seen in England, but they had both in Sydney, and he had brought over specimens of each for the purpose of cultivation. Another matter which he might mention as being of some interest was that some years ago he took occasion to examine the material filling the holes in wood made by wood-boring Larvæ. This consisted of their excreta. They had in Australia some very large moths—one species was as much as one ounce in weight—the larvæ of which penetrated the trunks of trees, and as they did so they threw out a large quantity of a powdery material, which was the woody matter after it had passed through the intestinal canal of the larvæ. If a small portion of this matter were placed on a slide with a little water, a number of *Filariæ* appeared, and the

question was how did they get there? His own impression was that they came from the intestinal canal of the larva.

The President thought this an interesting suggestion, and that they ought to try and trace the matter out. It was very seldom, however, that they could dissect an insect without finding some sort of parasite inside it. Some time ago he dissected an earwig, and found that it contained a worm, which was full of ova.

The President asked Dr. Ralph if he could give them any information as to his own Microscopical Society?

Dr. Ralph said they were at present only few in number, but had several good workers amongst them. The Society was progressing, though slowly.

Dr. Ralph then gave some details respecting some deposits of diatoms. Some years ago he found two very large deposits near Melbourne. At that time a railway was being made across a swamp, and, the difficulties being great, the work went on very slowly, and a sound foundation was only obtained when the workmen had filled in 40 vertical feet of solid earth. Amongst the earth which was dug out of the swamp was a quantity of glutinous material which adhered to the spades like slime. He took some of this home for the purpose of examination, and when it was dry he found that he could blow it away in a diatomaceous cloud. This gelatinous matter appeared to be recent in the swamp.

Mr. J. D. Hardy described a peculiar condition of *Volvox* which he had found at Snaresbrook. It was called *Volvox stellatus* by some authorities. Drawings in illustration were made upon the board.

Mr. Ingpen said that Mr. Hardy appeared to have found a very interesting stage of *Volvox*, what he had described being the germ cell at the exact time of the expulsion of the spores. It was described and figured in "Carpenter on the Microscope," where it was called "Fertilized germ cell or oospore." It was a stage not often met with.

Mr. Hardy said he found it in the middle of a bed of *Nitella* in fruit.

The President announced that the date of the Excursionists' annual dinner was altered to Saturday, June 10th; also that at the next meeting of the Club nominations for Officers and Committee for the ensuing year would be made, and he hoped members would come prepared with names of candidates.

The proceedings terminated with the usual Conversazione, at which the following objects were exhibited:—

Aphis from Ivy	Mr. F. W. Andrew.
Orthoseira arenarea	Mr. W. J. Brown.
Volvox—specimens mounted in glycerine jelly	Mr. E. Dadswell.
Floscularia, Epistylis, Melicerta, &c.	Mr. H. R. Gregory.
Parasite of Flamingo	Mr. T. S. Morten.
Transverse Section of stem of *Lilium auratum*	,, ,,

Attendance—Members, 50; Visitors, 2.

June 9th, 1882.—Conversational Meeting.

The following objects were exhibited :—

Section of Shell of Periwinkle, Polarized ...	Mr. F. W. Andrew.
Fresh water Alga (sp. ?) from Walthamstow ...	Mr. T. H. Buffham.
Polyxenus lagurus	Mr. A. L. Corbett.
Volvox stellatus	Mr. J. D. Hardy.
Germ cells of *Volvox globator*	Mr. J. E. Ingpen.
Hair of Seal, *Phoca vitulina,* Polarized ...	Mr. T. S. Morten.
Tube dwelling Diatoms, *Encystoma paradoxum*	Mr. J. M. Offord.
Batrachospermum, Nitella, &c., from Stroud ...	Dr. T. Partridge.
Section of leaf of *Dracæna*	Mr. J. W. Reed.
Meristem zone in stem of do., showing thickening of stem by formation of new fibro-vascular bundles and ground tissue	,, ,,
Six slides of Calcium acetate	Mr. W. D. Smith.
Actinoptychus Grundelerii	Mr. G. Sturt.

Attendance—Members, 36 ; Visitors, 5.

June 23rd, 1882.—Ordinary Meeting.

T. Charters White, Esq., M.R.C.S., L.D.S., &c., President, in the Chair.

The minutes of the preceding Meeting were read and confirmed.

Mr. Thomas Campbell, Dr. Alex. Garden, Mr. John Alex. Ollard, and Mr. Stephen Trinder were balloted for and duly elected Members of the Club.

The following additions to the Library and Cabinet were announced, and the thanks of the Meeting voted to the respective donors :—

"Proceedings of the Royal Society" ...	From the Society.
"Journal of the Linnean Society" ...	,, Mr. T. C. White.
"Journal of the Royal Microscopical Society"	,, the Society.
"Journal of the Microscopical Society of Victoria"	,, ,,
"Transactions of the Hertfordshire Natural History Society"	,, ,,
"Bulletin of the Belgian Microscopical Society"	,, ,,
"Science Gossip"	,, the Publisher.
"The Analyst"	,, the Editor.
"The Northern Microscopist"	In exchange.
"The American Naturalist"	,,
"The American Monthly Microscopical Journal"	,,
"Annals of Natural History"	Purchased.
"Micrographic Dictionary," Part XII. ...	,,

A series of Hydroid Zoophytes illustrating Dr. Hincks' Treatise		From Dr. M. C. Cooke.
Five slides of Parasites...	„	Mr. H. E. Freeman.
Six slides of *Calcium acetate*	„	Mr. W. D. Smith.

The Secretary placed on the table a bottle of Miller's Caoutchouc cement for mounting purposes, which it was stated was well adapted for forming cells suitable for all kinds of media. He also placed on the table two cells formed with this cement to illustrate its use. He remarked that the cement could be diluted with absolute alcohol, should it be required more liquid.

The President said he had examined the cells, which had been made a fortnight, and the rings were still elastic, which was a great advantage in mounting, especially in glycerine.

The President referred to the donation of two volumes of specimens, comprising a series of Hydroid Zoophytes, presented by Dr. M. C. Cooke, and asked the members to pass a special vote of thanks to Dr. Cooke, which was unanimously responded to.

The Secretary gave notice on behalf of the Committee of a proposed re-arrangement of the sentences of Rule III., in order to remove all ambiguity as to the respective nominations by the Committee and the Members. In another Society that had adopted the same wording as ours a question had arisen which was only settled by a long and elaborate nomination.

The proposed rearrangement would make the first part of Rule III. read thus:—"III. That at the ordinary meeting in June nominations be made of candidates to fill the offices of President, Vice-Presidents, Treasurer, Secretaries, Reporter, Librarian, and Curator, and vacancies on the Committee. That the President, Vice-Presidents, Treasurer, Secretaries, Reporter, Librarian and Curator be nominated by the Committee, and that the nominations for vacancies on the Committee be made by the Members, by resolutions duly moved and seconded, no member being entitled to propose more than one candidate."

The President, referring to the approaching Annual Meeting, announced that the time had arrived for nomination of Officers for the ensuing year. The Committee had, as usual, nominated the President, Vice-Presidents, and Officers, namely, as President Dr. M. C. Cooke, as Vice-Presidents Mr. Hildebrand Ramsden, Mr. Chas. Stewart, Mr. T. C. White, and Dr. Cobbold; Hon. Treasurer, Mr. Gay; Hon. Secretary, Mr. Ingpen; Hon. Secretary for Foreign Correspondence, Mr. H. F. Hailes; Hon. Reporter, Mr. R. T. Lewis; Hon. Librarian, Mr. Alpheus Smith; Hon. Curator, Mr. C. Emery.

In pursuance of the rules the following members of the Committee would retire, namely, Mr. Reed, Mr. Sigsworth, Mr. Hailes, Mr. Goodinge, and Dr. Cobbold.

The President having invited nominations to fill these vacancies, the following gentlemen were duly proposed as members of the Committee:—

Mr. H. R. Gregory,	proposed by	Mr. Freeman,	seconded by	Mr. Dunning.
Mr. J. D. Hardy	„	Mr. Dadswell	„	Mr. Gay.
Mr. J. W. Groves	„	Mr. Reed	„	Mr. Dadswell.
Mr. E. Jaques	„	Mr. Hailes	„	Mr. Delferier.

Mr. D. W. Greennough, proposed by Mr. A. Smith, seconded by Mr. Priest.
Mr. W. J. Scofield ,, Mr. Emery ,, Mr Reed.
Mr. E. M. Nelson „ Mr. Newton „ Mr. Groves.

The Secretary announced that the names of these candidates would be placed on the ballot paper in the order determined by lot by the President as provided by the rules, and not alphabetically.

The President announced that the Committee had appointed Mr. Hainworth as Auditor on their behalf, and he requested the members to nominate a second on behalf of the Club.

Mr. Dobson was proposed as Auditor on behalf of the Club by Mr. Oxley, seconded by Mr. Jaques, and elected *nem. con.*

Mr. Nelson exhibited and described a new objective, constructed by Messrs. Powell and Lealand. He had been much engaged in examining various minute organisms, such as Bacteria, which he had treated as diatoms or other test objects, and resolved them, as it were. It would be very important if morphological distinctions could be made out in these organisms, and certain Bacteria or Micrococci could be identified with a particular disease. The lens he was using was one of Messrs. Powell and Lealands 1-25th wide angle-glasses with two fronts. In using it he was greatly struck with the increase of working distance on reducing the aperture. With an aperture of 1·40 the objective worked through tolerably thick cover glass ; with an aperture of 1·14 it would work through a test diatom slip easily, so that the slide could be reversed, and the object viewed from the back. The 1-25th objective of 120° balsam angle worked through glass ·006 easily. When using Moller's type slide, which had a rather thick cover, the definition was remarkably fine. It resolved *Amphipleura pellucida* with direct central light through an achromatic condenser, without slot or stop. He remarked that if the aperture were over 1·25 the difficulty of making the objective was enormously increased. The front lens, as at present constructed, was more than a hemisphere ; it was skilfully fixed to a piece of thin glass ·003 in thickness, and they all knew the difficulty of handling such delicate glass without breaking it. Messrs. Powell, however, cemented the front lens of their new objective to a piece of this glass, which was then fitted to the objective. Mr. Nelson then described an adaptation of the fine adjustment to the substage. In working with high powers he found it very necessary to get an exact adjustment of the condenser, and this was extremely difficult with the ordinary coarse adjustment. In one instance he was endeavouring to show bovine tubercle in a large cell. It was a very thick section, and the object to be shown was extremely minute. He had thoroughly examined the object at home, but when he got to the meeting it took him a quarter of an hour before he could hit off the exact focus with the coarse adjustment. If the object was the smallest degree within or outside the focus of the condenser it instantly disappeared. The fine adjustment was also useful as a protection in using the condenser with thin slips. It was just as dangerous to rack up the condenser as it was to screw down the objective. The fine adjustment consisted of a cone at the end of a screw ; when the screw was turned in, the cone pushed up the substage, which was pressed down by a spring. On withdrawing the cone, the spring pushed the substage down.

He was then exhibiting *Amphipleura pellucida* under the microscope with a power of 2,300 diameters, and it was distinctly beaded in a very striking manner.

The President observed that it was a pleasure to the Club to have Mr. Nelson come up to show his fine preparations, and invited remarks or questions on the new lens.

Mr. Ingpen said with regard to the brass and glass portion of Mr. Nelson's observations it certainly was difficult to overrate the importance of the production of such objectives as those he had mentioned. All fine and delicate work would have to be verified by oil immersion objectives, which were the greatest advance of the last few years, and rendered a great deal of the work of examination and recognition of minute organisms easy, which a little while ago was practically impossible. It was a good illustration of the delicacy of such work, that it was found necessary to fit a fine adjustment to the achromatic condenser. Many fine achromatic condensers were at present almost useless owing to the imperfect rack adjustments of the substage, which were hardly ever sufficiently well made.

The President inquired if Mr. Nelson had used fluids of high refractive index for immersion glasses, or was there any particular difficulty in doing so? He remembered that several years ago Sir David Brewster tried to make lenses of very dense fluids.

Mr. Nelson replied that he had no experience of anything besides ordinary oil of cedar and oil of fennel. He had not tried oil of pimento.

Mr. Ingpen remarked that with regard to that question the principles were now pretty well understood. The fluid for a homogeneous lens was required to be of the same refractive index and dispersive power as the crown glass of which the front lens was made. With regard to the visibility of objects in fluids of various refractive indices, that point was also governed by well-known principles. In the case of a diatom the refractive index of which would be about 1·4, if placed in air we got a contrast between the refractive index of air 1 and the diatom 1·4. If the diatom were placed in water, with refractive index of 1·33, there was less contrast. In balsam or oil of turpentine a delicate diatom became almost invisible. If the refractive index of the mounting medium were much increased, as in the case of phosphorus of refractive index 2·1, a very great contrast was obtained in the other direction; and the diatom would be very visible by this contrast, with the additional advantage that the whole aperture of the immersion lens was used, which was not the case with an object mounted in air.

Dr. Ralph, of Victoria, South Australia, made some remarks upon the action of hydrocyanic acid combined with ammonia on the tissues of certain plants, for instance the vine. A thin slice of the plant when very tender showed a remarkable coloration, varying from the edge inwards. In certain vascular tissues the treatment gave a distinct red or claret colour, which passed through the tubes from one end to the other, giving an artificial injection. The Virginian Creeper showed a centre of a bright ruby colour. After the lapse of a quarter of an hour all this colour disappeared. The only explanation he could offer was the action of iron in the tissue. Formic acid in its nascent form attacked the iron and gave the transient

coloration. Formic acid alone gave some coloration, but it was not so vivid as when ammonia was added. He had tried the experiment with a number of different plants ; all gave some change, but none equal to the vine.

The President inquired if he had tried the green leaf of the Virginian Creeper.

Dr. Ralph replied that the cells in the leaf had come to a perfect state, and they would not respond. It was the early sap which was charged with something that gave the colour. If a thin section of the mid-rib of the Creeper were used the same appearance would be obtained. The action of the hydrocyanic acid on the tissues seemed to point to some action on the iron.

Mr. J. W. Groves, referring to the trouble often experienced in cleaning dirty slides, said that he did not care to use vitrol or other strong acids. He had tried Hudson's extract of soap, which hurt nothing, and cleaned the slides to perfection. If the slides were put into a solution of the extract, and left for a few days, the balsam, cement, and everything else would clean off beautifully.

The President announced the excursions and meetings for the ensuing month, and the meeting closed with the usual Conversazione, when the following objects were exhibited :—

Eggshell of Crocodile	Mr. F. W. Andrew.
Trichodactylus osmiæ, Bee-acarus ...	Mr. H. E. Freeman.
Bacillus of Tuberculosis (from sputum from human lung), showing the beaded structure with extreme clearness Transverse Striæ on *Amphipleura pellucida*, mounted dry on cover, shown by accurately centred Achromatic Condenser without slot or stop ... These objects were exhibited under a new 1-25th inch oil immersion objective, N.A. 1·38 (130° balsam angle) by Messrs. Powell and Lealand	Mr. E. M. Nelson.
Winged petiole of *Citrus aurantium*, showing essential oil glands, &c. ...	Mr. J. W. Reed.
Section of petiole of *Drosera rotundifolia* ...	Mr. F. Wood.

Attendance—Members, 54 ; Visitors, 5.

July 14th, 1882.—Conversational Meeting.

The following objects were exhibited :—

Marine Annelid (sp. ?)	The President.
Skin of *Scyllium stellare*	,,
Collections of Plant Sections	Mr. T. Curties.
Phthirius—Two projections provided with Hairs	Mr. H. J. Bound.

Feet of Foreign Geometric Spiders—*Nephila chrysogaster* and *N. rivulata*, showing peculiar serrations on claws	Mr. H. E. Freeman.
Transverse section of Elder, stained ...	Mr. H. R. Gregory.
Ranatra linearis, three and twelve hours old	Mr. J. D. Hardy.
Hydrodictyon of curiously deformed growth	Mr. J. E. Ingpen.
Wing of Orange-tipped Butterfly... ...	Mr. T. S. Morten.
Amphipleura pellucida, shown with Zeiss' oil immersion objective, N.A. 1·25	Mr. E. M. Nelson.
Section of petiole of *Viburnum lantana* ...	Mr. J. W. Reed.
Section through folded and opposite leaves of ditto	„
Section of young stem of ditto	„

Attendance—Members, 40 ; Visitors, 7.

JULY 28, 1882.—ANNUAL GENERAL MEETING.

T. CHARTERS WHITE, Esq., M.R.C.S., L.D.S., &c., President, in the Chair.

The minutes of the preceding meeting were read and confirmed.

Dr. W. C. Ondaatje and Mr. B. Williams were balloted for and duly elected members of the Club.

The following additions to the Library and Cabinet were announced:—

"Proceedings of the Royal Society" ...	From the Society.
"Journal of the Linnean Society" ...	„ Mr. T. C. White.
"Proceedings of the Bristol Natural History Society"	„ the Society.
"Proceedings of the Geologists' Association"	„ the Association.
"Science Gossip"	„ the Publisher.
"Eleventh Annual Report of the Chester Society of Natural Science" ...	„ the Society.
"Journal of the Postal Microscopical Society"	„ the Society.
"The Analyst"	„ the Publisher.
"American Naturalist"	In exchange.
"American Monthly Microscopical Journal"	„
"Annals of Natural History"	Purchased.
Parts of "The Micrographic Dictionary"	„
"A. C. Cole's Studies in Micro Science" ...	„
"Challenger Reports," Vol. iv.	„
12 Slides of Micro-photographs by the late Wm. Moginie	From Mrs. Moginie.
Seven slides of preparations of the Embryo Chick	„ The Dinner Committee.

The President, in moving a vote of thanks to the several Donors of books and slides, asked for a special recognition of the valuable and interesting collection of Micro-photographs presented by Mrs. Moginie. Mr. Moginie

was one of the earliest practisers of micro-photography, and these specimens were therefore specially interesting. He also asked for their special thanks to the Dinner Committee for their valuable donation.

These votes of thanks were carried unanimously.

The President, in making the usual announcements for the ensuing month, referred to the whole day excursion to Whitstable fixed for the following day, for which Mr. Hembry had made special arrangements. Mr. Siebert Saunders would take charge of a dredging party, and others would be able to explore various interesting features of the neighbourhood.

This concluded the proceedings of the Ordinary Meeting, and the business of the Annual General Meeting was then proceeded with.

The President read the amendment to Rule III., as moved by the Secretary at the last meeting, and the amendment was put to the meeting in the usual way, and carried unanimously.

The President appointed Mr. M. Hawkins Johnson and Mr. G. D. Brown to act as Scrutineers.

The Secretary read the Seventeenth Annual Report of the Committee.

Mr. Hembry, in moving the adoption of the Report, regretted that so few members attended the ordinary meetings of the Club ; he hoped for improvement in that respect during the year. It was satisfactory to see the library increased, and that the Club maintained its numbers. He had much pleasure in moving the adoption of the Report.

Mr. Hardy seconded the motion, which was carried unanimously.

The Secretary read the Treasurer's annual statement of account.

Mr. F. A. Parsons proposed that the Treasurer's account be passed.

Mr. Wm. Goodwin seconded the motion, which was put and carried unanimously.

The President then delivered his annual address, in which he took a retrospective view of the science of optics, especially in relation to microscopy, from the earliest times, tracing the progress of microscopical research, together with the gradual improvements in the microscope down to the present time.

Mr. Dadswell moved a vote of thanks to the President for the address they had listened to with so much pleasure.

Mr. Dunning seconded the motion, which was carried with acclamation.

The President in acknowledging the vote of thanks, referred to the difficulty there was in getting up an address, nearly every subject having been dealt with by others, so he thought he would go back and show that in the old times they were not content with what they knew ; and, just as we were now, were always striving after further discoveries and better results.

The President then announced the result of the ballot to be as follows:—

President—Dr. M. C. Cooke.

Vice-Presidents—Dr. Cobbold, Messrs. Hildebrand Ramsden, Charles Stewart, T. Charters White.

Five New Members of the Committee—Messrs. W. J. Scofield, J. D. Hardy, E. Jaques, E. M. Nelson, and J. W. Groves.

Hon. Treasurer—Mr. F. W. Gay.
Hon. Secretary—Mr. J. E. Ingpen.
Hon. Secretary for Foreign Correspondence—Mr. H. F. Hailes.
Hon. Reporter—Mr. R. T. Lewis.
Hon. Librarian—Mr. Alpheus Smith.
Hon. Curator—Mr. Charles Emery.

Mr. Wm. Goodwin expressed a desire that more facilities of access to the books in the Library might be afforded to members. It had no doubt occurred to many members who desired information on a particular point, that there was some difficulty in obtaining the literature on the subject. which was often scattered about among the scientific periodicals, and he thought that members might have more facilities for taking down and examining the books in the library at the meetings of the Club. At present no doubt the Librarian was strictly right in keeping the library closed, but he thought more facilities might be given to members to refer to the books themselves.

The President was sure the Librarian would endeavour to meet the convenience of every one applying to him for books for temporary reference.

The Secretary remarked that in other societies it had been found very inconvenient for the library to be open, and members to take down books and replace them, frequently in wrong places. The Librarian would, he was sure, give every possible facility to members who wished to refer to the books consistently with the proper regulation and care of the library.

Mr. Watkins said he was afraid the suggestion he was about to make would meet with even less favour than the previous one. He considered that it would be a great convenience to many members if a plan could be adopted for circulating the unbound periodicals, such as serial works, which appeared month by month, among such members as might desire to read them. This was done in some other societies. A list of the members to whom the journals were to be sent could be attached to the book, and each gentleman on the list would read the book and pass it on to the next on the list, and the last named member would return it to the Librarian. One of the first objects of a library was to consult the convenience of the readers. He considered it should not be looked upon solely with regard to the safety of the books, which should be the duty and care of all the members.

Mr. Waller suggested that the question must be left to the Committee.

Mr. Hopkins observed that the Librarian already had plenty of work, and suggested that he should be voted a salary before giving him more duties to perform.

The President spoke in complimentary terms of the excellent arrangement of the library, and remarked that he did not think any salary would reward the Librarian so well as the heartfelt approval of the members.

The President then vacated the chair in favour of his successor, Dr. Cooke, who was cordially received.

Dr. Cooke said he thought he felt rather nervous, but the kind reception he received led him to expect that the Club would have every consideration for every mistake he might happen to make during the coming year. He

felt some satisfaction in taking his position. They had had eleven Presidents since 1865. Of that number nine were members of or associated in some intimate way with the profession which had the credit of helping people into the world and out of it. He did not belong to the majority. He felt some satisfaction that, as a somewhat representative man, he belonged to the minority. Then, again, only one of the past Presidents was a botanist, the other ten were zoologists, or professed zoologists; therefore being a professed botanist, that branch of science would be somewhat represented in himself. There was another curious coincidence. After the first five Presidents came Dr. Braithwaite, after five more he occupied that position, so once in six years they had a botanist occupying that chair. He looked for their support, and he should try to carry out his old rule, "Whatever was worth doing was worth trying to do well."

Mr. J. C. Fox moved a vote of thanks to the Officers of the Society for their services during the past year.

Mr. Parsons seconded the vote, which was put to the meeting and carried unanimously.

The President, on behalf of the meeting, proposed a vote of thanks to the Auditors and the gentlemen who had acted as Scrutineers that evening, which was proposed and passed in the usual manner.

The President, in moving a vote of thanks to the Council of University College for their continued permission to hold the meetings of the Club in their Library, observed that he was glad that one of the earliest of his acts as President was to move this vote of thanks. It was many years since they had removed from their little room in Piccadilly to come to the College. They had during the whole period enjoyed the closest intimacy with some of the College authorities, and had held their meetings in that admirable apartment, and if the thanks of any Society were due to any such foster parents, he thought the thanks of that Society were due to the authorities of University College for their kindness during such a long period.

The vote of thanks was passed unanimously.

The meeting closed with the usual Conversazione, and the following object was exhibited:—

Foot of *Leptogaster cylindricus*—a specimen in which the usual pads are wanting (Sc. Gos. xii. p. 157) ...	Mr. H. E. Freeman.

Attendance—Members, 54; Visitors, 5.

On the Estimation of the Numbers of Foraminifera found in Chalk.

By M. C. Cooke, M.A., A.L.S., President.

(*Read August 25th*, 1882.)

Having thought that it would be of advantage to place on record the result of my calculations of the number of foraminifera found in Kentish Chalk, and an opportunity now presenting itself of introducing the subject, I may premise by stating, that the investigations were made some fifteen years since, although the details were never printed ; and subsequent, but less complete, estimates lead me to infer that the conclusions are substantially correct.

In order to test the accuracy of other observers, as well as to procure some new determinations of the number of organisms, approximately, to be found in the chalk, I took one ounce of chalk from the pit and washed away the lighter fragments by continued washings, until I obtained a sediment of nearly pure foraminiferous shells ; half of this I cleaned as much as possible by boiling in caustic potash, and ultimately found that I had enough material to mount 190 microscopical slides, each of which contained upwards of 1,000 perfect shells, so that in one ounce of chalk I had isolated 400,000 shells. Afterwards I washed another ounce more carefully, and calculated that I had then obtained upwards of half a million of entire shells, without reckoning the fragments which had been washed away, or the thousands probably, that had been decanted off with the water in 40 or 50 washings. Hence I am convinced that I am very far short of the maximum when I name half a million of Foraminifera as contained in every ounce of chalk from that pit. The little lump of chalk which I procured for these experiments weighed 16 pounds or 256 ounces, and consequently contained the shells of one hundred and twenty-eight millions of Foraminifera—a number easily named, easily written, but by no means so easy to imagine ; a number which it would occupy a

man for ten years to count, even if he could count sixty per minute for twelve hours daily.

Ehrenberg calculated that there are one million and one third of organisms in a cubic inch of chalk, and this is, without doubt, very nearly correct. My block of chalk contains, roughly, about 216 cubic inches, and according to Ehrenberg's calculation would contain 288 millions of shells ; my calculation, derived by another process, was 256 millions, and this was made before I was aware of Professor Ehrenberg's computation, and serves to strengthen my position, not only that I am below the actual number, but that I am very near the correct number. If, therefore, I adhere to my own calculation, it will be from a desire *not* to exaggerate. I must think that these two independent calculations greatly strengthen each other, and are enough to establish the fact that between one million and a quarter and one million and a third of Foraminiferous shells are contained in each cubic inch of Kentish Chalk.

To communicate some idea of the vast number of shells contained in one ounce of chalk, we will suppose that each shell were as large as the shell of the common garden snail (*Helix aspersa*). If such were the case, and these shells were placed side by side, then the half million shells in one ounce of chalk would form an unbroken line of twelve miles in length, or if we take the whole of the shells contained in the lump I spoke of just now, and reckon them after the same rate at 128 millions, then, if they were as large as snail shells, and were placed in a line, that line of shells would be 3,072 miles in length, and would occupy an express train seventy-seven hours to go from one end to the other, at the continuous rate of forty miles an hour.

It would be worse than folly to attempt any calculation of the myriads of Foraminifera which are entombed in the chalk beds of England alone, without reference to the similar beds in continental Europe. The chalk pit from whence my specimens were derived is situated at Swanscombe in Kent, and the present firm inform me that, from this pit they have obtained more than half a million tons of chalk, or 561,895 cubic yards. Figures would fail to convey any idea of the number of Foraminifera which this single firm has disturbed and removed from their last resting-place. These minute shells would require 150 of most of them placed side by side to extend over one-twelfth of an inch, and if we take the commonest form—*Globigerina*—the diameter of which is about

$\frac{1}{150}$ of an inch, it would require nearly ten millions placed end to end to reach a mile. Taking this, then, as the basis of our calculations, we shall find that our Kentish firm have dug from this chalk pit Foraminifera sufficient, minute as they are, to extend for, at the least, 1,006,915,840 miles. From one chalk pit, out of many hundreds in active operation, one manufacturer of lime and cement has, within about a quarter of a century, dug out the shells of these minute animals, each one of which is nearly invisible to the naked eye, in sufficient quantity to reach more than a thousand millions of miles, adopting a moderate calculation; yet even this is a number more vast than our minds can grasp—what therefore must be the number included in the white cliffs of Dover—in all the chalk beds of Kent and Sussex?

On a Quick-acting Adapter for Microscopical Objectives.

By E. M. Nelson.

(*Read September* 2, 1882.)

It is obvious to everyone that the present method of screwing or unscrewing objectives is a very tedious one.

To remove this objection I have thought of several devices which I was obliged to abandon because they would not be interchangeable with existing arrangements.

The plan which I now bring before you has no such objection. It was suggested to me by the method employed by the French in closing the breech of their breech-loading ordnance. It consists in simply cutting away three portions of the Society's screw in the nose piece and three similar portions in the objective. To fix on an objective it is merely necessary to push it home in the nose-piece and give it one-sixth of a turn to the right; a similar turn to the left will as readily release it.

In order that these altered nose-pieces and objectives may be made interchangeable with one another, all that is required is that similar portions of the screws shall be cut away.

To insure this I have had a template made by Messrs. Powell and Lealand, which I have much pleasure in presenting to the Club.

A mark should be made on the objective to shew the proper position for its insertion in the nose-piece.

I propose that this mark be made on the front of the nose-piece, and a similar one on that side of the objective which is to be placed in a line with the front of the nose-piece at the time it is inserted.

ADVANTAGES.

This arrangement appears to me to possess the following advantages :—

The rapidity with which objectives may be changed.

It can be applied without interfering with existing arrangements.

It can be made interchangeable.

The alteration will not interfere with the interchangeability of the parts so altered with those that have not been altered.

No new apparatus is required.

The centering of the objectives is not in the least disturbed.

The change can be made with nearly the same rapidity as with the double or triple nose-piece, the objectionable weight of which is avoided.

The rapidity of fixing is of use in renewing the fluid when working with immersion objectives.

DISADVANTAGES.

It will not be interchangeable because the existing arrangements are not interchangeable.

The objectives must be inserted in the nose-piece in one position.

Care must be exercised in turning a stiff adjustment collar in a direction that will unscrew the objective.

[NOTE.—This is a disadvantage which to a great extent applies to existing arrangements, for screw collars are only fitted to high powers and wide angled lenses which have short-working distances. If care, therefore, were not taken in turning a stiff adjustment collar in a direction that would unscrew the lens, it would soon be screwed down on the cover glass.]

Persons who are unskilful in handling mechanical appliances will perhaps find some trouble in acquiring facility in using it.

On the Method of Using Abbe's Test-plate.

By Dr. C. Zeiss, of Jena.

(*Communicated by* J. E. Ingpen, *September* 22, 1882.)

The test-plate is exclusively designed for the examination of objectives with reference to the correction of spherical and chromatic aberration, and for estimating the thickness of cover-glass for which the spherical aberration is most efficiently corrected. The test-plate consists of a series of six cover glasses, silvered on their under surfaces, and ranging in thickness from 0·09 mm. to 0·24 mm., cemented side by side on a slide. The thickness of each cover is written on the silver coating.

Groups of parallel lines are cut through the silver; these are so coarsely ruled that they may easily be resolved by the lowest powers; but, from the extreme thinness of the silvering, their contours afford a very delicate test for the most powerful and wide-apertured objectives.

To examine an objective of large aperture, the plates are to be focussed in succession, observing each time the quality of the image in the centre of the field, and the variation produced by using alternately central and the most oblique illumination. When perfect correction for spherical aberration exists for the cover-glass thickness of the plate under examination, the contours of the lines in the centre of the field appear perfectly sharp by oblique illumination, without nebulous doubling or indistinctness of the fine irregularities of the edges. If after exactly adjusting the objective for oblique light the illumination is made central, no alteration of the adjustment should be necessary to show the contours with equal sharpness.

If an objective fulfils these conditions with any one of the plates, it is free from spherical aberration when used with cover-glasses of that thickness; on the other hand, if every plate shows nebulous doublings, or a confused indistinct appearance of the edges of the silver lines with oblique illumination, or if the objective requires a

different adjustment to get equal sharpness with central as with oblique light, then the spherical corrections are more or less imperfect.

Nebulous doubling with oblique illumination indicates over-correction of the marginal zone; want of sharpness of the edges, without marked nebulosity, indicates under-correction of this zone; the alteration of the adjustment for oblique and central illumination —that is, difference of level between the image in the peripheral and central portions of the lens system—points to insufficient concurrence of the separate zones, which may be due to either an average under or over-correction, or to irregularity in the conveyance of the rays.

The test of chromatic correction is based on the character of the colour bands which are visible by oblique illumination. With good correction the edges of the silver lines in the centre of the field should show but narrow colour bands in the complimentary colours of the secondary spectrum, namely, on one side yellow green to apple green, on the other violet to rose. The more perfect the correction of the spherical aberration the clearer this colour band appears.

To obtain obliquity of illumination extending to the marginal zone of the objective, and a rapid interchange from oblique to central light, Abbe's illuminating apparatus is very efficient, as it is only necessary to move the diaphragm in use vertically nearer to, or further from the axis by the rack and pinion provided for the purpose. For the examination of immersion objectives, whose aperture, as a rule, is larger than 180° in air, and homogeneous immersion objectives which considerably exceed this, it will be necessary to bring the under surface of the test-plate into contact with the upper lens of the illuminator by means of a drop of water, glycerine, or oil. In this case the change from central to oblique light may be easily effected by the ordinary concave mirror, but with immersion lenses of large aperture, it is impossible to reach the marginal zone by this method, and the best effect has to be searched for after each alteration of the direction of the mirror. For the examination of objectives of smaller angular aperture (under 40°—50°), we may obtain all the necessary data for the estimation of the spherical and chromatic corrections by placing the concave mirror so far to one side that one edge of it is about in the line of the axis, and therefore that the incident cone of rays only fills one half of the aperture of the objective, when the sharpness of the contours and the cha-

racter of the colour bands can be easily estimated. Differences in the thickness of the cover-glass within the ordinary limits are scarcely noticeable with such objectives. It is of fundamental importance, in employing the test as above described, to have brilliant illumination, and to use an eye-piece of high power.

When, from practice, the eye has learnt to recognise the finer differences in the quality of the contour images, this method of investigation gives very trustworthy results, and differences in thickness of cover glasses of 0·01 mm. to 0·02 mm. can be recognised with objectives of 2 mm. or 3 mm. focus. With oblique illumination the light must always be thrown perpendicularly to the direction of the lines.

The quality of the image outside the axis has no bearing on spherical and chromatic correction in the strict sense of the term. Indistinctness of the contours towards the borders of the field of vision arise, as, of rule, from unequal magnification of the different zones of the objective ; colour bands in the peripheral portion (with good colour correction in the middle) are caused by the unequal magnification of the different coloured images.

Imperfections of this kind, improperly called "curvature of the field," are shown to a greater or less extent in the best objectives when the aperture is considerable.

Note on a Specimen of Bacillus tuberculosus prepared by Dr. Gibbes' method.

By G. C. Karop, M.R.C.S., &c.

(*Communicated September* 22, 1882.)

Although, as a general rule, I am adverse to the discussion of medical topics in a non-medical society, I thought that as Mr. Curties had kindly offered to show a specimen of *Bacillus tuberculosus* for me, it would be but right on my part to say a few words concerning it, if I were called upon to do so. As many of you are doubtless aware, the theory of the bacterial origin of disease is at present occupying the attention of scientists and pathologists in all parts of the world, and although it is comparatively quite a new idea, the literature of the subject has already become immense. It may well, too, engage the sympathy of the laity, for no other theory seems so hopeful as this to give us a clue towards the abolition of many diseases which affect all conditions and classes of the human race.

Everybody has heard or read something of the researches of Pasteur and others on the subject of fowl-cholera, spirillum or splenic fever, &c., in sheep and other domestic animals, and therefore I need only say that the present tendency of investigation in this direction is to show that every specific disease or group of diseases is characterised by a special bacillus, microzyme or germ which developes rapidly in the blood or tissues and may so pervert nutrition or upset function as to destroy life.

The majority, if not the whole, are contagious or capable of inoculation, and not the least wonderful thing about some of them at least, is the fact that after they have been cultivated or grown in successive crops, in some suitable medium, they lose their fatal character, and if they are then inoculated, only produce mild symptoms, and are preventative against an attack of the original form of the disease.

Recently, Koch, of Berlin, one of the most eminent investigators in this direction, made the startling discovery that tubercular con-

sumption is characterised by a special organism or bacillus, a specimen of which I have the honour of submitting to your notice this evening.

The first thing that may strike the observer who has any acquaintance with these low forms, is, how can it be possible to differentiate as special organisms, what for the most part are but spots or rods under even the highest powers? and after reading Tyndall's "Floating matter in the air," and knowing how universally present such organisms are in the lower strata of the atmosphere, one is apt to be rather sceptical in such a case as the present, and to incline to the opinion that although bodies are undoubtedly present, they are mere products of decomposition, or other accidental phenomena.

This, however, is met by the curious fact that certain forms are selective of certain anilin dyes, and are capable of being stained only by such colours, and it is entirely a matter of experiment to ascertain the affinities any form may possess. As to how far this may be the case, and on what it depends, whether on the presence or absence, or density of envelope or what not, can only be determined by experience; remembering too when so many experiments are being made and so many methods employed, contradictions and mis-statements are sure to be made, and it is only by patient and repeated observation that any definite opinion can be arrived at. For instance, in the present case. Dr. Koch's method of showing the bacillus, was difficult, tedious, and uncertain. It was improved by Dr. Ehrlich, his assistant, but his procedure, too, gave uncertain results, and was very complicated. It is described in the last number of the "Journal of the Royal Microscopical Society."

Finally, Dr. Heneage Gibbes, of King's College Hospital, has invented a process whereby the bacillus, if present, can be shown, with comparative ease and but little trouble. The method he employs is given at length in the *Lancet*, of Aug. 5th, but as some here may not have seen his description, and would wish to know it, I subjoin a short resumé of the process.

The necessary reagents are as follows:—A solution of magenta in pure anilin, this is the stain. A solution of chrysoidin in water, to which a little thymol is added, and some common nitric acid, one part to two of water. A small portion of the suspected sputum is spread very thinly on a cover-glass and allowed to dry perfectly, it is then passed through a spirit flame once or twice to ensure its

dryness, and then immersed in a few drops of the magenta stain and allowed to remain for about 15 to 20 minutes. It is next transferred to some of the dilute acid which apparently destroys all the colour, and from this the cover is put into distilled water and well rinsed, when a faint tinge of colour returns. It is now put into the chrysoidin solution, which gets rid of any surplus anilin which may remain and slightly stains the ground of nuclei and shreds of lung issue which may be present.

After remaining in the chrysoidin for a few minutes, it is transferred to absolute alcohol to get rid of the water, then left to dry, and when thoroughly dry, mounted in balsam, and examined with a one-eighth objective.

If the bacilli be present, and the specimen is successful, they will be seen as short rods coloured a brilliant magenta. Of course the process, like all descriptions, sounds somewhat tedious, and the drying of the film of sputum on the cover *is* slow, even if, as it should be, it is spread very thinly and evenly ; but there is no difficulty about it, and if it be found as it is stated by the inventor, to stain no other bacillus but *bacillus tuberculosus*, which is a matter for experiment to determine, you may readily imagine the immense aid it promises to be in the diagnosis of early cases of phthisis, unless it proves, alas ! to be but another *ignis fatuus* which has too often led astray the investigator of this terrible disease.

(*May* 21*st*, 1883.)

As it is now some time since the above was written, I have been permitted by the Editor to supplement it by a few additional remarks.

Repeated observation and experiment has as yet only strengthened the belief in the specific nature of the bacillus. It has, I believe without exception, been found in every case of true tubercular phthisis examined, and it is said to have been identified in the urine of patients suffering from tubercular disease of the kidneys or bladder.

From a series of observations made by Dr. West (*Lancet*, April 21, 1883) and others, there appears to be some slight ratio between the number and arrangement of the bacilli and the severity of the cases, specimens from early or improving cases showing the bacilli scattered singly and comparatively few in number. On the

other hand, where there is great breaking down of the lung and near the fatal termination of the disease, they are grouped in masses and in great quantity; but there are many exceptions to this, and individual cases vary considerably.

There seems to be no doubt that they increase most rapidly, and are to be found most readily in the caseous matter lining the walls of the cavities in the lung, so that the thick, and not the watery, part of the sputum should be used for preparing specimens.

Again as to the methods of staining the bacillus. In the above communication Dr. Gibbes' procedure was advocated as the easiest and simplest, and it is still, with some later improvements, the one ordinarily used; but Dr. Neron (*Lancet*, Dec. 23, 1882) and some others have shown that it does not differ in any essential way from that of Ehrlich, which preceded it. A solution of methyl blue is now used instead of chrysoidin for staining the surrounding matters, as it affords a greater contrast to the magenta red; no second stain however is really necessary. Recently Dr. Gibbes (*Lancet*, May 5th) has given a "Rapid Method of Demonstrating the Tubercle Bacillus without the use of Nitric Acid," which it may be as well to transcribe. "The stain is made as follows:—Take of rosanilin hydrochloride two grammes, methyl blue one gramme; rub them up in a glass mortar. Then dissolve anilin oil 3 c.c. in rectified spirit 15 c.c.; add the spirit slowly to the stains until all is dissolved, then slowly add distilled water 15 c.c.; keep in a stoppered bottle. To use the stain:—The sputum having been dried on the cover-glass in the usual manner, a few drops of the stain are poured into a test tube and warmed; as soon as the steam rises pour into a watch-glass, and place the cover-glass on the stain. Allow it to remain for four or five minutes, then wash in methylated spirit until no more colour comes away; drain thoroughly and dry, either in the air or over a spirit lamp. Mount in Canada balsam."

A certain degree of temperature is necessary for successful staining, and there is no doubt that many of the earlier experiments failed from being made in too cold a room. All observers now agree that a temperature of about 100° to 104° F. is almost absolutely necessary as a condition of success. This may be attained by either warming the stain first or keeping the covers while staining in a warm chamber.

On the Fibro-vascular Bundles in Ferns and their Value in Determining Generic Affinities.

By J. W. Morris, F.L.S.

Communicated by T. Curties.

(*Read October 27th*, 1882.)

PLATES IV. and V.

Everyone, it may be assumed, has, at some time or other, made a section, however rough, of the *stipes* or frond stalk of the common Bracken (*Pteris aquilina*), and observed the diagram of the Oak tree which the fibro-vascular bundles with their scalariform ducts, thus seen in section, are thought to represent.

A wider acquaintance with sections of this character discloses some highly interesting affinities, and suggests a law of correspondence and development which, if once accurately laid down, must, it is thought, be of value in the determination of genera.

It is by no means suggested that genera can be determined by this evidence alone. The existing characteristics, hitherto exclusively relied upon, are indispensable and primary, but it is believed that the due consideration of this feature of growth would tend to correct or remove many existing anomalies which at present sorely afflict and confuse the student of Fern classification.

No one who has attempted to master the existing arrangements and apply them practically to the identification of species, or even genera, is insensible of the anomalies which exist.

The present classification—or classifications rather—however scientific in their broader features, are little better than capricious in a multitude of individual instances.

We should be in despair in our Phanerogamic Botany if one authority placed the Tulip tree amongst Tulips, and another transferred the *Salisburia adiantoides* from the Yews to the Adiantums—but it is pretty nearly as bad as this in Fern-land.

A few instances, taken almost at random, will suffice to show what strange confusion reigns.

There is a common fern known in the nurserymen's catalogues as *Polypodium trichodes*, which rejoices in the *aliases* of *Aspidium*, *Lastrea*, *Phegopteris*, and *Hypolepis*—a range of genera represented in the Kew classification of Mr. J. Smith by the numbers 5, 70, 75, 84 and 85.

Cystopteris fragilis, to take a familiar fern enough, is *Polypodium* of Linnæus, *Aspidium* of Swartz, and even *Cyathea* of Smith's English Botany—or 5, 70, 76, 131 of the Kew classification.

So also *Nephrolepis* is in turn a *Polypodium*, an *Aspidium*, and a *Nephrodium*.

Struthiropteris is *Onoclea*; *Onychium* is *Lomaria*, *Trichomanes*, and even *Pteris*.

These are not, be it remembered, the vagaries of catalogues composed with insufficient knowledge, but the *aliases* of conflicting authorities in Botanical Science.

These illustrations, as every Fern student knows to his cost, might be indefinitely extended. There is hardly a genus which is exempt. There are few of these anomalies which would not have to yield to the verdict of the *supplementary test* which is now proposed.

It is the object of this brief paper to indicate the groups into which ferns seem to fall by the evidence of the diagram of the section of the stipes.

To simplify the matter I shall speak of the arrangement of the fibro-vascular bundles as seen in section as the "Hieroglyph."

The examination of many Hieroglyphs establishes two conclusions:

1st. In certain genera—and by far the larger number—the evidence of the Hieroglyph accords with the existing classification. It is *plus* and, therefore, surplus.

2nd. In certain genera the evidence of the Hieroglyph, so far from sustaining the existing classification, invalidates it, and would transfer many a fern from the genus to which it is now assigned to another. The evidence in these cases is *minus* and material.

What is the net value of these conclusions? Shall we accept the affirmative evidence as superfluous, and dismiss the negative as impertinent, simply saying, "So much the worse for the Hieroglyph!" or shall we collect and group all this evidence, *plus* or *minus*, pro or con, and see what assistance it can afford us in at

least revising a classification which is honeycombed with contradictions?

As a contribution to this revision, and as in, some sort, an argument for its necessity, the following results of the examination of many hundreds of species and some scores of genera are now submitted. I regret that the limits of my opportunity preclude any claim to completeness in the investigation.

Advantage has been taken of the process of double staining to make the sections as distinct as possible.

Diversified as are the Hieroglyphs in the various species, they are all susceptible of distribution into about four groups.

1. Punctiform. Fibro-vascular bundles in isolated dots.
2. Sigmatic. Fibro-vascular bundles collected in two S-shaped canals.
3. Sinuous. Fibro-vascular bundles collected in a zigzag intra-marginal canal.
4. Medullary. Fibro-vascular bundles within a central canal—occupying the place of a medulla.

Of the first of these, *Polypodium* may be taken as the type; of the second, *Athyrium;* of the third, *Dicksonia;* of the fourth, *Gleichenia.*

More exactly, however, 12 groups present themselves.

1. Punctiform. Irregular. Bundles in scattered dots. *Polypodium vulgare.*
2. Punctiform. Symmetrical. Bundles arranged as in the nails of a horseshoe. Two at the base larger. *Drynaria.*
3. Sigmatic. Bundles collected within walls of Sclerenchyma forming two S-shaped figures like those in the sounding-board of a violin. *Athyrium.*
4. Sigmatic-arcuate. S-shaped figures anastomising at the upper ends so forming a single arcuate figure. *Microlepia.*

N.B.—Though 3 and 4 are often distinct throughout the stipes, both forms are to be found in many individual plants, notably in the so-called *Polypodium trichodes,* which upon this evidence would be separated from *Polypodium.*

5. Aureate. Hieroglyph a symmetrical ear-shaped arch with terminal incurved lobes. *Osmunda.*

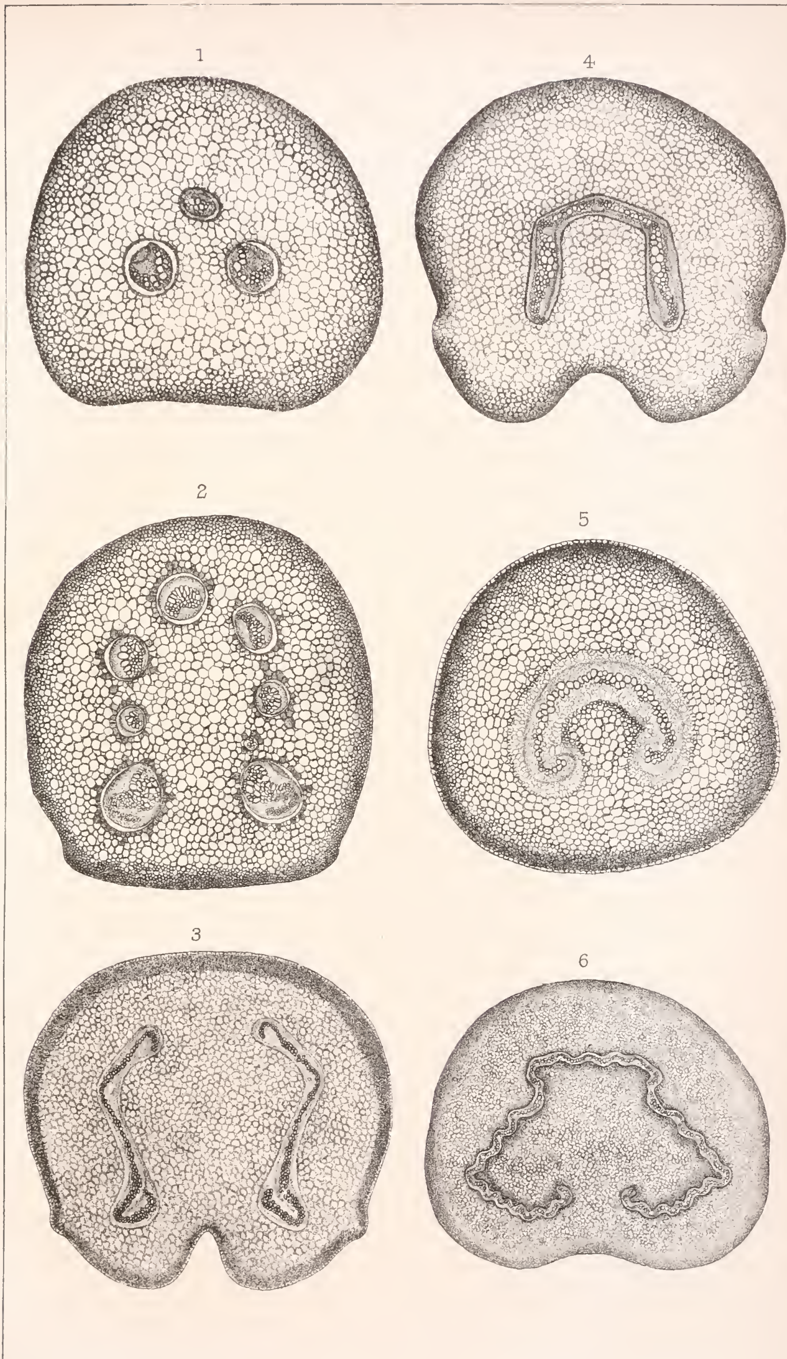
6. Sinuous. Hieroglyph somewhat resembling in outline 4 and 5, but ducts distributed within a sinuous canal in a distinct zigzag catena. *Dicksonia.*
7. Sinuous-arcuate. Hieroglyph resembling bridge of a violin—the zigzag preserved, but the arch receiving a marked lateral depression. *Sitolobium.*
8. Sinuous-arcuate, interrupted. The zigzag broken up into separate bundles apparently dispersed, but susceptible of being resolved into the figure of No. 7. *Pteris aquilina.*
9. Medullary. Sigmatic-arcuate, as in 4, but contained in central canal. *Trichomanes.*
10. Medullary. Sigmatic-cruciform. The contiguous S-shaped figures within a central canal presenting the Hieroglyph of a St. Andrew's cross. *Scolopendrium.*
11. Medullary. Arborescent. Hieroglyph within central canal of a tree-like form. *Gleichenia.*
12. Medullary. Indefinite. Bundles within central canal without particular symmetrical arrangement. *Platycerium grande.*

All these shade into each other through different species by degrees almost imperceptible. *Pteris aquilina*, *e.g.*, is an interesting puzzle. All the exotic *Pterises* with which I am acquainted — *tremula*, *argyræa*, &c., &c., are arcuate or sinuous-arcuate, and have little resemblance to *P. aquilina*, whose place is apparently nearer to the tree ferns. This may, of course, be urged as "so much the worse for the Hieroglyph," but the question arises whether this universal fern, the root of which the New Zealanders say is in the middle of the world, is not the ally of the *Sitolobiums* and *Balantiums.*

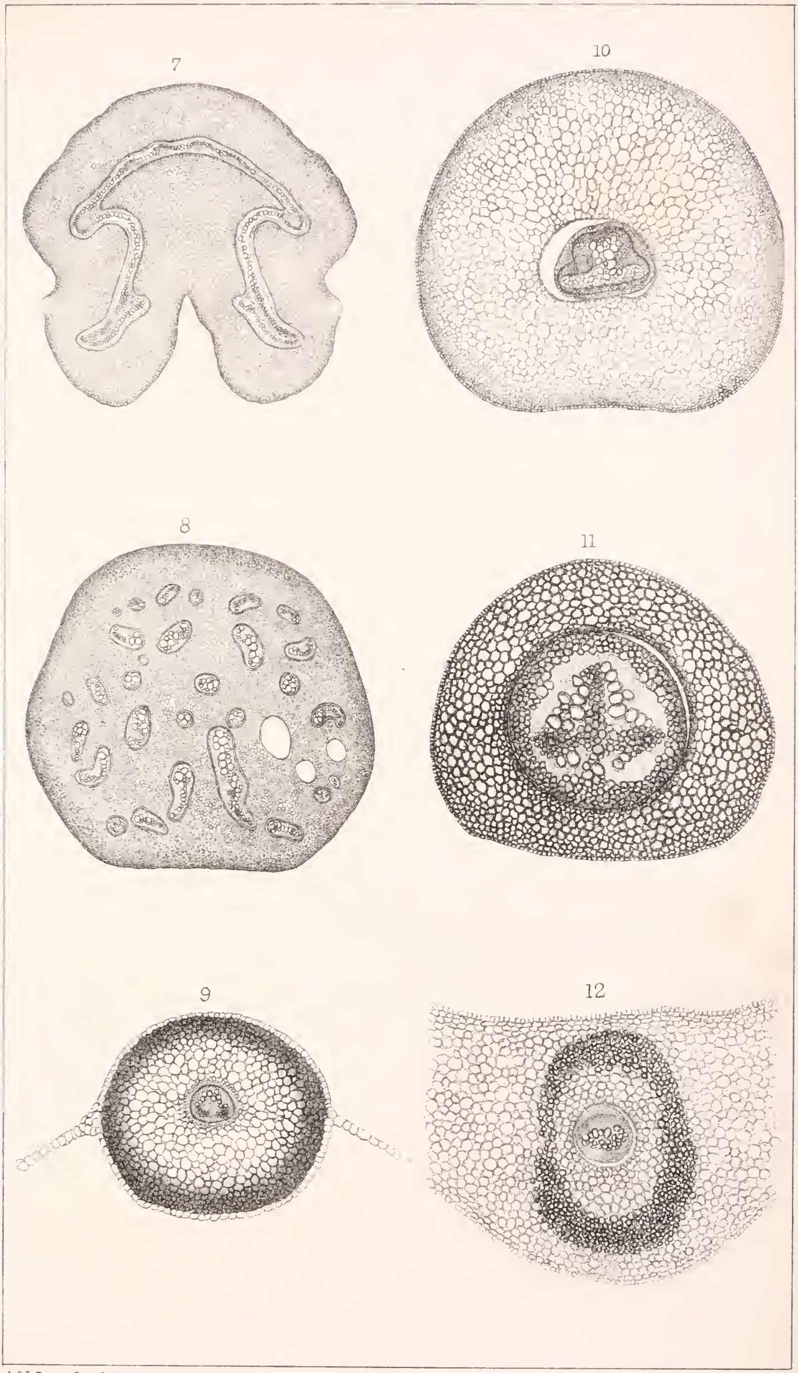
It is interesting to observe that *Aspidium*, *Sagenia*, *Cyrtomium*, *Nephrodium*, *Lastrea*, and *Polystichum*, so nearly approach each other in the accepted characteristics that Kunze calls them sections of *one* genus. Now all these are punctiform, except *Nephrodium*, which is sigmatic.

Ferns as widely distinct in general appearance and habit as the filmy *Todea* and the proud *Osmunda* are united by their fructification into one family, and the classification holds good by the test of the Hieroglyph.

The accompanying figures are from drawings of sections made about the middle of the stipes.



A.H. Searle del. et lith. Hanhart imp.



A.H. Searle del. et lith.

Hanhart imp

What is their evidence worth?

I would venture to submit that—1st. The arrangement of the fiibro-vascular bundles should be taken into account in the determination of genera—especially where the accepted characteristics fail to establish the position.

2nd. The gradation from one arrangement of these bundles to another, so marked at greater intervals, so slight at successive stages, asks for recognition in an arrangement of genera correspondent to this development.

The sections illustrative of these observations are in the cabinet of the Club.

Notes on Diatomacearum Dillwynii, or The Genera and Species of Diatomaceæ in "The British Confervæ" of Dillwyn.

By F. Kitton, Hon. F.R.M.S., Mem. Cor. Soc. Belge de Mic.

(Read November 24, 1882.)

PLATE VI.

The few forms belonging to the class Diatomaceæ figured and described by L. W. Dillwyn in his "British Confervæ" (4to, 1809) comprise only the filamentous species. Being unacquainted with their siliceous character and other important differences which distinguish the Diatomaceæ from all other algoid forms, he placed them among the Confervæ (a genus to which the early botanists seem to have relegated all the "water-weeds") on account of their filamentous growth and "jointed" appearance, caused by the cohesion of the frustules, and which he considered analogous to those in what we now call Oscillariæ, &c. He, however, recognises Decandolle's genus *Diatoma.*

Having had the opportunity, through the kindness of Dr. M. C. Cooke, of examining Dillwyn's own specimens, I am able to refer them to the genera and species in which these forms are now placed.

Diatoma, Decandolle.—Plantæ pseudo-parasitica oculo nudo vix conspicuæ, filamentis simplicibus articulatis, articulus in adulta planta transversum sectis.

The species, arranged in the section *Articula solutis* of my "Synopsis," constitute a natural family, and may be referred to this genus.

Conferva striatula.—C. filis simplicibus compressis dilutè viridibus dissepimentis alternatim solutis, articulis diametro vix brevioribus transversis striatis (E. B., t. 1,928).

On Fuci and Conferva, in the Sea at Cromer (=*Rhabdonema arcuatum,* F. K.).

C. flocculosa.—C. filæmentis sub-simplicibus, compressis, minutis,

dissepimentis solutis articulis prismaticis alternatum refractis.—Pl. VI., f. 2.

C. flocculosa, Roth., " Catalecta Botanica " i.; " Fl. Germ." iii., part 1, p. 523.

This singular plant was found for the first time in Britain by my friend Joseph Woods, jun., and myself, growing in a pool on Hampstead Heath, since which time I have observed it in various other places. Its structure is so extraordinary that, notwithstanding the figures and descriptions in the " Catalecta Botanica " and my own repeated observations, I can hardly now allow myself to assign it a place among the perfect productions of Nature. At first I considered it as *C. pectinalis* broken to pieces, but a little examination rendered that idea inadmissible. It certainly has every appearance of a broken plant, but J. Woods, jun., has observed it in a state in which the joints cannot be so disposed as to make the two parts of the line, which one might otherwise imagine continued originally the whole length of the plant, coincide.

It is a very small species, seldom exceeding a quarter of an inch in length, and varying in colour from a pale to a greenish-brown. The filaments are rarely branched. Their form is not easily ascertained, but they always appear to me to be very much compressed, and the joints only adhering to one another by single points, look like a string of parallelograms united at the corners. Each joint has a double line running through the middle of it, and some very faint transverse bands frequently appear. In some cases, however, this is entirely wanting, or has escaped the power of my glass.

(This form was first figured and described but without name in the " Abridgment of the Philosophical Transactions," 1703, both of which have been reproduced in my article on the " Early History of the Diatomaceæ." " Science Gossip," vol. xvi., p. 77, 1880. It is the *Tabellaria flocculosa* of modern authors.—F. K.)

C. pectinalis.—C. filis simplicibus pellucidis, acuminatis compressis cinereis plerumque accuminatis, dissepimentis sæpé solutis; articulis brevissimus medio-crystallino-pellucidis = *C. pectinalis*, Müller, in " Nov. Act. Pet." iii.; *C. bronchialis*, Roth., " Cat. Bot." i., p. 186; " Fl. Germ." iii., p. 520.—Pl. VI., f. 1.

Müller, who first found this singular species, and published an excellent figure of it, observes that it is abundant in the ditches about Pyrmont.

The filaments are of a dirty green colour, seldom exceeding half

an inch in length, and, to the unassisted eye, resemble decayed vegetable matter. When entire, they gradually taper to a point, and, as Müller observes, bear considerable resemblance to the antennæ of a lobster, but I could never observe the appearance of cylindricity in the figure given in it by that botanist. The dissepiments are very conspicuous, and at these the filaments frequently break, the parts remaining connected at only one extremity, which when it repeatedly takes place, gives the plants so much the appearance of *flocculosa* as to make it somewhat doubtful whether the species are distinct. The joints are very short, and appear coloured towards each end by a green fluid, which, soon after the plant is taken from the water and it approaches decay, collapses, sometimes forming into small globular masses, and sometimes disappearing entirely.

(The statement that the filament tapers to a point is, as we know, incorrect. This apparent tapering to a point was caused either by a filament being gradually twisted until its edge was visible at one of the extremities, or two filaments were partially superimposed, which would also cause the tapering appearance. Its apparent resemblance to *C. flocculosa* is not easily explained. Dillwyn's own preparation does not indicate any resemblance to that species in the attachment of the frustules to each other at the angles.=*Eunotia (Himantidium pectinale* of authors).—F. K.)

C. teniæformis.—C. filis simplicibus, compressis dilutè viridibus dissepimentis; articulis diametro dimidio brevioribus, obsoletè variegatis demum refractis ("E. Bot.," tab. 1,833).

On *Conferva fucoides*, Beachy Head. Mr. Borrer.

C. Biddulphiana.—C. filis simplicibus compressis, longitudinaliter striatis, viridibus, dissepimentis solutis ; articulis quadratis. transversim fasciales, sub-alternatim refractis ("E. Bot.," tab. 1,762).

On marine algæ, Southampton. Miss Biddulph.

This plant, which, as well as *C. striatula*, *C. teniæformis*, and *C. obliquata*, is here introduced upon the authority of "E. Botany," appears to be, as Dr. Smith observes, really an extraordinary production, but it seems scarcely possible that all the figures in that plate should belong to the same plant, or if they do, does it not lead to a suspicion that the species of this family have been unnecessarily multiplied by authors ?

C. obliquata.—C. filis ramosis, compressis flexuosis fusco albi-

dis; dissepimentis solutis, articulis quadratis, obliquis, transversim fasciatis, maculatis, alternatum, refractis ("E. Bot.," tab. 1,889).

On Fuci and Confervæ in the sea. Miss Biddulph.

(*C. teniæformis* according to Harvey, "Manual of British Algæ," 1841, and Greville in "Hooker's English Flora," 1883. =*Diatoma marinum*=*Grammatophora marina* of recent authors, to which species *C. Biddulphiana* must also be referred. Dillwyn's specimen, which I have examined, leaves no doubt as to the identity of the two species. F. K.)

C. fasciata.—C. filis simplicibus tenuibus mucosis purpurea-fuscus, articulis medio-fascia angusta transversum notatis longitudem diametrium æquantibus.—Pl. VI., f. 5.

On decayed leaves and sticks, &c., in a ditch at Stoke Newington. Joseph Woods.

Mr. Woods discovered this species in slippery masses about 1½ inch long, of a purple brown colour, and forming a thick coat over decayed substances in a ditch at Stoke Newington. The length and diameter of the joints is equal, and in the middle of each there is the appearance of a dark narrow transverse band, which, however, proceeds from the internal organization of the plant, and therefore appears somewhat shorter than the diameter of the filament.

(*C. fasciata*=*Melosira varians*, F. K.)

C. lineata.—C. filis simplicibus, tenuibus fragilibus fuscis; dissepimentis contractis; articulis linea una alterave tenuissima striatis, diametro sub-triplo longioribus.—Pl. VI., f. 4.

Among the leaves of water plants in the river Lea at Walthamstow.

In March, 1802, I found a single small specimen of this species among a jelly-like substance of the Tremella kind, which almost covers the water-plants in the Lea at Walthamstow. The filaments are simple, and very brittle, and of a brown colour. I have not since been able to find more than a few imperfect filaments of this plant. The length of the joints in some filaments is about thrice, and in others not more than twice, the diameter, and they are generally marked with one or two transverse lines at certain distances from each other.

(Dillwyn's specimen is *Melosira subflexiles* of the "Synopsis."—F. K.)

C. nummuloides.—C. filis simplicibus, tenuibus, fragilibus fusco

aureis, articulis diametro sub-brevioribus demum in glomerules sub-ovatis moniliformes approximates mutatis.—Pl. VI., f. 3.

Among the leaves of water-weeds in the river Lea at Walthamstow.

In March, 1802, I found a few detached filaments of the present plant mixed with those of *C. lineata* among the Tremella-like slime with which, as I have before mentioned, many of the plants in the river Lea are covered.

I have not discovered any filaments that appear to be at all perfect, but they seem to be sufficiently so to prove that the plant differs materially from every other British species.

The filaments are cylindrical, of a brittle nature, and reddish, yellowish, or yellowish-brown colour. The internal vesicles which constitute the joints appear *to be at first cylindrical, but at length collapse into an oval form, so as to give to the filaments, when highly magnified, some resemblance to a series of guineas* (italics mine.—F. K.)

The length of their joints are generally somewhat less than their diameter.

(The slide from Dillwyn's collection marked *C. nummuloides* is without locality or date, but the name is in the author's handwriting. The species is attached to a marine alga, upon which were also growing *Melosira Borreri*, *Grammatophora marina*, and *Synedra affinis*. The form figured and described in the " British Confervæ " could not have been from the river Lea at Walthamstow, as all the above-named forms are marine.—F. K.)

C. ochracea.—C. filis ramosissimus tenuissimus perfragilibus, densissime compactis, gelatinam ochraceam, tamen in floccos secedentum constituentibus.

In pools and ditches ; common.

(This form was placed by Hassall " Freshwater Algæ," vol. i, p. 400, as *Melosira ochracea* and with Diatoms as synonymous with *Gallionella ferruginea*. A careful examination of Dillwyn's specimen does not confirm this, and I am unable to distinguish anything like a Diatom frustule. A fragment treated with nitric acid was destroyed by its action. Dr. Kutzing ("Bacillarien," p. 56) says :—" Ganz ausgeschlossen muss werden *Gallionella ferruginea* Ehr. welche kein Diatomee sondern eine Confervea est." Dr. Werneck, in 1841, gave figures of *G. ochracea* and *G. ferruginea*, and which represent two distinct species. His figure of a filament of

the latter magnified 3,000 diameters (?) is very much like Dillwyn's figures of *C. nummuloides*.—F. K.)

C. fœtida.—C. filamentis ramosis, flaccidis, vergatis coadunatis, apicibus liberis, ramis consertis sub-dichotomis dissepimentis obsoletis articulis longiusculis granula elliptica solitaris includientibus.

Ulva fœtida, Vaucher, "Histoires des Confervæ" d'eau douce, p. 244, t. 17, f. 3. *Monema Dillwynii*, Grev.; *Schizonem* a *Dillwynii*, Sm.; *Berkeleyi Dillwynii*, Grun. Stagnant pools in the salt marshes of Cley, Norfolk, Mr. Hooker; Bantry Bay, the Mumbles Lighthouse, Glamorganshire.

In the early part of last June (1808) I discovered this curious production of nature growing under the Mumbles Lighthouse in a pool left by the tide near low water mark, where, had not the tide receded unusually low, it could not have been exposed to view. This I suppose to be a natural situation, but I have since learnt that Mr. Hooker had gathered it two months before in the salt marshes above mentioned, and had ascertained it to be the plant described and figured by Vaucher . . . I have not ventured on introducing it as a vegetable without considerable hesitation on account of its strong peculiar oily smell, resembling that of some zoophytes, but the eye, even when assisted with the highest powers of a microscope, cannot discover any appearance at all sufficient to distinguish it from the tribe with which it is now arranged.

C. fœtida grows in thick bushy tufts near two inches in length. . . . The filaments are very flaccid, and peculiarly slender in proportion to their length. They are twice or three times branched in an irregularly dichotomous manner. . . The length of the joint is nearly double the diameter. Each joint contains an egg-shaped mass resembling *C. jugalis* (=*Zygnema deciminum*, Agh.), which, from analogy, I suppose are formed by a collapsion of their joints or internal granules, and are somehow connected with fructification, as supposed by Vaucher, but, like him, I have had no opportunity of investigating the matter.

(This description well illustrates the very imperfect state of the microscope at the time Dillwyn wrote the above description. The so-called joints he, of course, did not see, and simply assumed their presence because he had detected them in the other Confervæ. I append Vaucher's description of this form, which agrees very fairly with that of Dillwyn.—F. K.)

Ulve fétide.—Filamens cylindriques, solides, gelatineux, dont l'extremite est en barbe de plumes, et qui dans leur vieillesse n'est plus de subdivisions.

Cette singuliere ulve se recontre dans toutes les eaux fraîches et courantes des petits ruisseaux. Elle est adhérente aux pierres du fond pendant tout les mois de l'année, sa couleur est d'un brun noirâtre vers les extremites; mais les tubes eux-memes, surtout ceux qui sont jeunes, ont un coup-d'oeil verdâtre. Cette ulve est probablement celle que Villars a rencontrée dans les cuves de Sassenage à laquelle il donne des racines (Voyez Tab. 56iéme de son ouvrage) et qu'il designe sous le nom de *Conferve fétide.* Elle parait entièrment formée de tubes transparens et remplis de grains moins réguliers que ceux des espèces precédentes (Ulve minime). Ces grains s'allongent et semblent redonner l'ulve, mais je n'ai pas assez suivi leur developpment pour affirmer quelque chose a cet égard. L'odeur qu'elle repand est très forte, et ressemble aux odeur animales et sur-tout a celle corps que commencent a entrer en putréfaction. Quoiqu'elle ne soit pas décrite par Linnè ni par la plupart des autres botanistes, je ne doute pas qu'elle ne se rencontre par tout; son port la rapproche des conferves, mais son organisation l'en éloigne.—" Histoire des Confervees d'Eau Douce," par Jean-Pierre Vaucher. An xi. (p. 244.)

DESCRIPTION OF PLATE VI.

Fig. 1.—*Conferva pectinalis* }
Fig. 2.— „ *flocculosa* } The shading represents the endochrome coloured green in the original figures.
Fig. 3.— „ *nummuloides.*
Fig. 4.— „ *lineata.*
Fig. 5.— „ *fasciata.*

These figures are accurate copies of Dillwyn's illustrations, which represent the forms as seen under the sixth power of his microscope. This was apparently equal to about 200 diameters.

Fig. 1

Fig. 2.

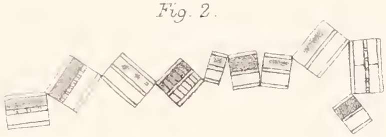


Fig. 3.

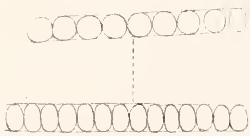


Fig. 4.

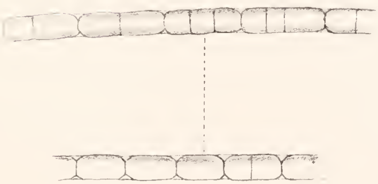


Fig. 5.

F.K. del. A.H. Searle lith.

Hanhart imp.

On the Statoblasts of the Freshwater Sponges.

By B. W. Priest.

(*Read November 24th*, 1882.)

PLATE VII.

Having lately been engaged in examining the Statoblasts of the species of Freshwater Sponges at present known, and being struck with their marvellous structure and beauty, I thought a few words about them might interest some of the members of the Quekett Club, although I know the two British species have been ably treated by Mr. Waller.

I shall not enter into the general structure of the different species now known, but confine myself to the Statoblasts of the typical specimens of each genus, noting any particular deviation of form that may occur as we proceed, and mentioning any peculiarity in the form of those Sponges in which the Statoblasts are unknown.

The Freshwater Sponges were first made known as far back as 1696, and in 1745 Linnæus described two species under the respective names of *Spongia fluviatilis* and *Spongia lacustris*, mentioning at the same time the presence of the small seed-like bodies generally associated with them.

These organisms have been named by different writers on the subject at various times, gemmules, ovules, ovisacs, spherules, capsules, and lastly statoblasts or winter eggs, from their close resemblance to the statoblasts of the Freshwater Bryozoa, not only in outward appearance but also in their being, according to Mr. Carter, similar in general internal structure, the difference being only in size and form, in having spicules instead of tentacular appendages on their surface, and in the mode of discharging their contents when matured.

Now, as there have never been any forms found in the Marine Sponges at all resembling the Statoblasts found in the Freshwater Sponges, a sharp line of demarcation between the two is here indicated by that circumstance alone.

The reason assigned for the Statoblasts occurring only in the Freshwater and not in the Marine Sponges is, that the former are often left high and dry for weeks, perhaps for months together, whilst the sea is constantly returning to cover the latter, they therefore do not require the protection to the ova from the influence of the atmosphere and other causes that the Freshwater Sponges would do.

The Statoblasts may be found most abundantly at the base of the sponge towards the autumn or winter, but in the warm summer days they are plentifully diffused throughout the entire body of the sponge, excepting, perhaps, quite the new growth.

The late Dr. Bowerbank placed the *Spongilla* under the genus *Isodictya*, on account of the skeleton structure agreeing so perfectly in the form of the spicules composing it, though distinguished from that genus by the peculiarities of the reproductive organs, viz., the Statoblasts, the *Spongilla* reproducing its kind after the manner of the Marine Sponges, that is to say, by ova proper, and division of the sarcode.

The two British species were the only ones known as Freshwater Sponges, until, in 1848 and 1849, Mr. Carter published his interesting "Memoirs on the Sponges found in the Bombay Tanks," which memoir will be found in the "Annals of Natural History" of those dates. Since then new forms and varieties have been met with in Europe, Asia, and America, but strange to say, none have as yet been brought from Africa, although no doubt they exist there.

Describing the Statoblast generally, it is about the size of a large pin's head, varying in this respect not only with the species, but in the individual, and can be seen with the unassisted eye.

In form it is more or less globular or oval, having a foramen or hilum, either lateral or terminal on the surface, generally at the bottom of an infundibular depression which leads to the interior.

If we make a vertical section with a sharp, thin knife, through the aperture of one of these bodies when dry, we shall observe that it consists of an internal globular cavity, filled more or less with a soft waxy substance, of a yellowish colour, which substance, when swollen out in water, will be found to be composed of a great number of thin transparent sacs, somewhat spherical, filled respectively with minute germinal matter, consisting of transparent germs of different sizes, the whole enclosed by a delicate investing membrane, slightly protruding at the aperture, and presenting a reti-

culated appearance like that of vegetable cell structure. Next comes a comparatively thick, chitinous membrane, of an amber colour, which, when viewed in the whole Statoblast, has a deeper colour than when separated.

Then comes another coating or crust which, in two instances, is composed of cell structure, hexagonal in section, but in the rest of a white granular or micro-cellular substance, which can only be seen by a very high power object-glass. It appears to afford a floating property, like cork, to the Statoblast, and varies much in thickness according to the species. Its composition is still, I believe, a disputed point, Meyen thinking it was lime, having a cellular formation, but in no case has it been known to effervesce when brought into contact with hot or cold acids.

This crust is charged or accompanied by spicules of different forms, variously arranged according to the species, and on which the classification of the Freshwater Sponges is now founded.

Although the Statoblasts have been known so many years, Johnston, in his description of the British species, does not mention the presence of spicules except in a foot-note, stating that Meyen, in 1839, discovered bi-rotulate spicules, and others with minute spines on their surface, evidently believing, at that time, that the two belonged to the one species of sponge ; perhaps a natural conclusion to have come to then, as the two were, and are often, found growing together in the same locality, and the microscopical appliances for seeing them were not then anything like so perfect as they are now.

In some species, as in *Tubella reticulata*, the Statoblast is enclosed in a distinct layer of spicules, which partake more of the character of the skeleton spicules of the Sponge, forming a capsular covering, in which it was probably developed.

We will now pass on to the classification of the Freshwater Sponges, as founded by Mr. Carter, on the form and structure of the Statoblasts, as far as present known, omitting for brevity the general structure of the Sponge, as I mentioned at the commencement of this paper.

The first genus comprises the *Spongilla*, containing ten species, whose Statoblasts are globular, crust thick, thin, and in some cases absent altogether, accompanied by minute acerate spicules, smoothed or spined according to species.

In *Spongilla Carteri* the spicules are smoothly acerate, and the crust is composed of pyramidal columns of dodecahedral or poly-

hedral cells, hexagonal as seen in section or when focussing for the surface, regularly arranged one above another in juxtaposition, perpendicularly to the outside of the chitinous coat.

This species has only been found as yet in India, Mauritius, and lately by Dr. Margo of Budapest, in Europe, in the Lake of Balaton. My own specimen, for which I am indebted to Dr. Matthews, comes from Jheels, opposite Benares.

The only British species of this genus is *Spongilla lacustris*, the Statoblasts of which have the spicules more or less curved, minute, stout and sharp-pointed. They are covered with stout recurved spines, the outer crust being composed of micro-cellular structure.

This species is found growing somewhat plentifully up the Thames, at Henley, Goring, and Marlow, and is also met with in Europe generally, North America, and Asia, but the finest specimens that I have seen have come from the Upper Thames.

The remaining eight species of this genus are *S. alba*, *S. pauperenta*, *S. cinerea*, *S. cerebellata*, *S. navicella*, *S. multiforis*, (so named on account of having several openings to the Statoblast, this species is also apparently devoid of a crust), *S. Lordii* and *S. nitens*. This last-named species has the pyramidal columns in the outer crust, like *S. Carteri*, all other species having the granular or micro-cellular structure.

The next genus is *Meyenia*, after Meyen, who first discovered the presence of bi-rotulate spicules characteristic of this genus, and it comprises eight species. The Statoblasts are globular or oval, the micro-cellular structure of the crust being charged with bi-rotulate spicules, that is spicules which consist of a straight shaft terminated at each end by a disk, even or denticulated at the margin, arranged perpendicularly around the chitinous coat, so that one disk is applied to the latter, while the other forms part of the surface of the Statoblast.

In *Meyenia fluviatilis* (*Spongilla fluviatilis* of Bowerbank) the species most generally known, and in which many varieties occur, as instanced in Mr. Waller's paper on that subject,* the umbonate disks are deeply and irregularly denticulated, and the shafts in some cases more or less spiniferous. The Bombay species, *S. Meyeni*, and the River Exe species, *S. Parfittii*, have both kinds of spicules, viz., smooth and spined, proving that they are only varieties of *M. fluviatilis*.

* "Q. M. J.," Vol. v, p. 53.

In *Meyenia plumosa* (perhaps the most beautiful of any of the freshwater Sponges as a microscopical object), the Statoblasts are oval; with the aperture lateral, the umbonate disk is of equal size and the margin is irregularly denticulated, with the processes more or less turned inwards. The shaft is long, straight, and sparsely spiniferous, the spines being large, conical, and perpendicular on their surface. I may mention here, that it is the only species of freshwater Sponge that has the flesh spicule stelliform, consisting of a number of arms of various lengths radiating from a smooth, globular body, the arms spined throughout. This species comes from Bombay.

The remaining six species are, *M. erinaceus*, *M. Leidii*, *M. gregaria*, *M. Capewelli*, *M. Baileyi*, and *M. anonyma.*

We now come to the genus *Tubella*, signifying a little straight trumpet, so named on account of the spicules, charging the crust of the Statoblast, having the shaft passing by a trumpet-like expansion into a disk at one end, this disk being larger than the other.

The Statoblast of this genus is either globular or elliptical, the aperture lateral or terminal. It comprises four species, *Tubella reticulata*, *T. paulata*, *T. spinata*, and *T. recurvata.* The typical species, *T. reticulata*, has the Statoblast elliptical, ovoid, aperture terminal, crust composed of micro-cellular substance, charged with inequi-birotulate spicules, consisting of a straight shaft passing by a trumpet-like expansion into the larger disk, with two or more spines about the centre, and furnished with a ring-like inflation towards the disk; which disk is circular, smooth, with an even margin, somewhat recurved, the opposite end of the spicule consisting of a circular umbonate head, regularly denticulated on the margin with six or eight conical processes. The spicules are arranged perpendicularly, so that the small end forms part of the surface of the Statoblast, whilst the disk rests on the chitinous coat. It is in this genus that the Statoblasts seem to have been developed in a capsular covering composed of spicules similar to those forming the skeleton of the sponge, which are bent, subfusiform, and rounded at the ends, only half the size and more thickly spined. This species comes from the River Amazon.

The remaining genus of which we know anything of the Statoblast, is named *Parmula*, a little round shield, on account of the form of some of the spicules. There are two species, *P. Batesii* and *P. Brownii.*

Taking *Parmula Batesii* as the typical species, we shall see that the Statoblast, besides being a beautiful object when magnified, is very curious in the arrangement of its spicules.

It is large, globular, and more or less tuberculated. Crust very thick, composed of micro-cellular structure, which grows out through the interstices of the reticulated arrangement of the skeleton spicules, and forms somewhat of a capsular covering to the Statoblast, as in *Tubella*, giving it the tuberculated appearance just mentioned. It is charged with, and surrounded by minute, thin, curved, fusiform, gradually sharp-pointed, spinous accrate, spicules irregularly dispersed through the substance, limited, both inside and outside, by a layer of parmuliform spicules, the former in contact with the chitinous coat, and the latter on the free surface of the crust, giving it a light-brown colour.

The parmuliform spicule is circular, flat, infundibuliform, terminating in a point, like a little round shield turned up at the margin, which is even. The spicules are arranged both internally and externally in the Statoblast in juxtaposition, more or less overlapping each other with the funnel-shaped process *outwards* in both instances, so that the surface is covered with little points.

The Sponges comprising *Tubella* and *Parmula* possess an extremely rigid reticulated structure, as also the next and last genus, *Uruguaya*, so named from having been found in the rapids of the river Uruguay. The only species is *U. corallioides* of which the Statoblast has not yet been discovered.

Dr. Dybowski has, I believe, found Sponges in Lake Baikal, in Central Asia, including a new genus, *Lubomirskia*, comprising four species with their varieties, but the Statoblasts were absent in all of them.

Without taking these into consideration, we have thus five genera of Freshwater Sponges, including 24 species, in only one of which the Statoblast is unknown. Two only of these have been found in the British Isles, varying in structure according to locality, &c. It would not surprise me if other species should be found some day, particularly as they seem to have existed in former years in larger numbers of species, as proved by the presence of the amphidiscs and spicules found in freshwater deposits, many of which are different in form from those at present known.

Referring to what I stated at the commencement of this paper, that Statoblasts do not occur in any known Marine Sponges, I have been asked occasionally, " What then do you call the bodies found

in *Geodia* and *Pachymatisma*, and termed by the late Dr. Bowerbank Ovaria ?" My answer is that they are certainly *not* Ovaria.

Dr. Bowerbank was evidently misled by the depressions which are found to exist in these bodies. If we break up any of them, as I have often done, from their earliest form of development, we shall find that *it is merely* a depression and *not* an aperture leading to an internal cavity, as no such cavity exists, and that the "globular crystalloids," as they are now termed, are consolidated aggregations of spicules radiating from the centre to the circumference, and forming one solid mass, being no more ovarian than the stellate forms of spicules found in *Tethya*, or the silicious or calcareous bodies found packed in the cells of some of the Tunicated Ascidians. Dr. Bowerbank's statement of their being Ovaria moreover is not borne out by the figures intended to illustrate what he says.

For further particulars, a paper by Mr. Carter in the "Annals of Natural History," for July, 1869, containing remarks on the same subject, may be consulted.

Since writing this, Mr. Carter has kindly sent me a copy of his paper in the "Annals of Natural History" for the present month, describing a new species from Bombay—*Spongilla bombayensis;* and also calling attention to one shortly to be published and described by Mr. Potts of Philadelphia, found at Chester Creek—*Spongilla segregata*, the Statoblasts of which are developed in a capsule, four together; the capsule being composed of hexagonal cells, such as are found in *S. Carteri* and *S. nitens;* the whole reminding one of the appearance of the tetrahedral form of the sporangium in certain plants.

Perhaps I ought not to leave the subject without making some statement as to the way the young Sponge is produced from the Statoblast, but as I unfortunately have not seen the process myself I may be allowed to quote Mr. Carter, our present great authority on the subject, as briefly as I can :—

"In due season the cellular contents are discharged through the foramen into the water, and undergo a remarkable development, appearing as a white flocculent substance, having a flat, transparent, irregular margin, containing numerous vesicles, whilst in its central portion are ova-bearing or reproductive cells. At the same time generally two kinds of spiculæ appear, which are formed in the interior of special nucleated cells. They at first present themselves as delicate lines, but rapidly grow by external additions

until they attain full dimensions. These additions are generally made more quickly at one point than another, rather than throughout their entire length, so that in their half-developed condition they present one or more bead-like inflations, which disappear when the growth is complete.

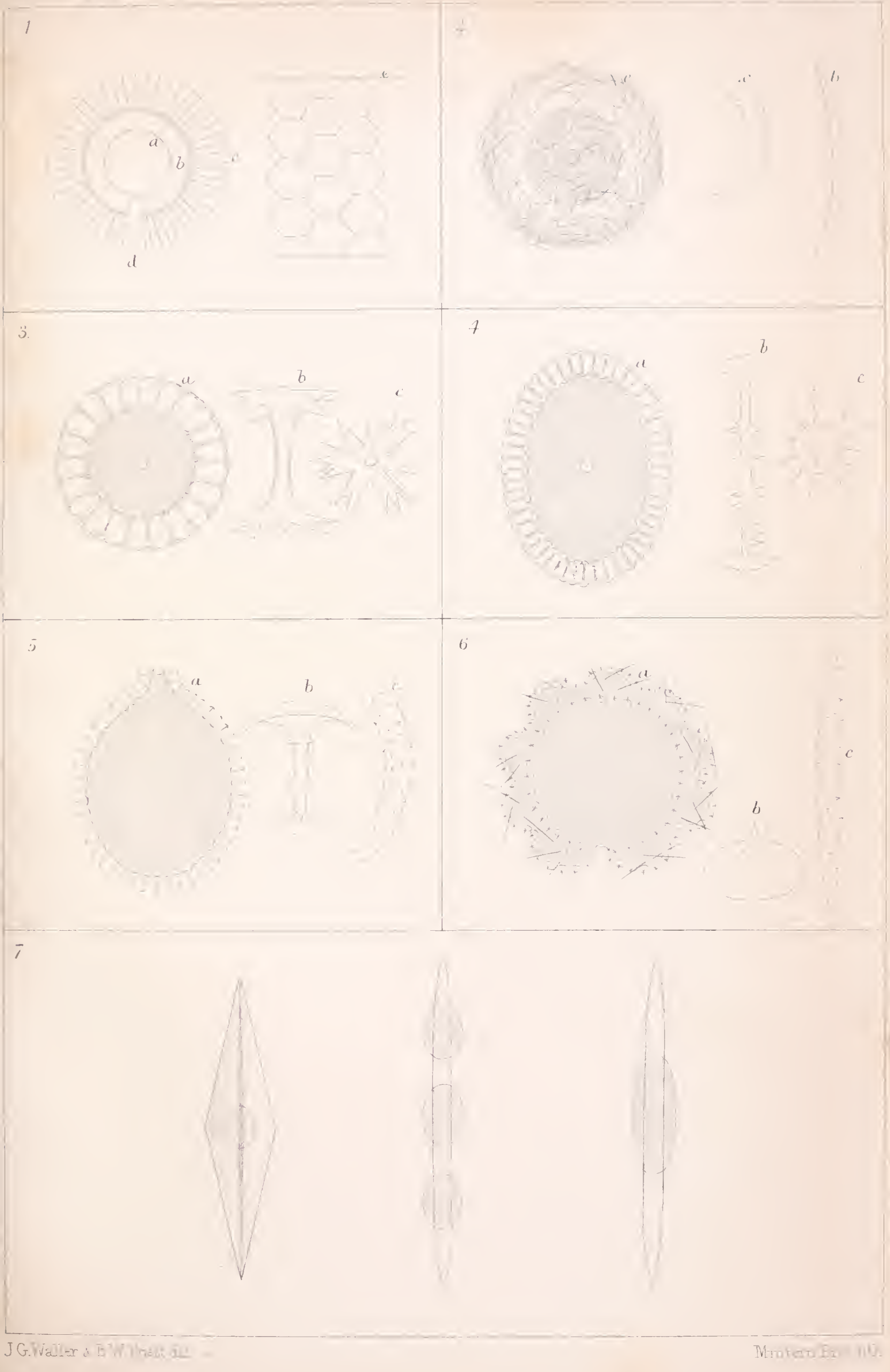
"When the growth of the sponge-mass has made some progress, the formation of a distinct investing membrane out of what was the flat transparent border, becomes obvious. This membrane is gradually detached from the central ova-bearing cells, either by the shrinking of the latter, or by the protrusion of bundles of spicules which force it outwards, leaving here and there open spaces between the membrane and the central cell mass.

"And so it proceeds until after the development of other spicules and canals formed for the passage of the water, the Sponge is perfected and continues to grow by adding to its general structure, until it arrives at its full size, which of course varies according to the locality and species.

"The process best suited for examining the structure of the Statoblasts in the dry state—which is the most easy method, many difficulties attending the examination fresh, when attainable —is to place four or five on a glass slip with a drop of strong nitric acid. Boil this to dryness over a *very* low spirit lamp. Do this three times. Then place the slip on the incline and pass water over it with a camel's-hair pencil until all the remains of the acid is washed out. Next with a sharp, *thin* knife like a lancet, divide, in half or in quarters, one or two more Statoblasts, and adjust them round the remains of the foregoing (or on a separate slip if you prefer it.) Add a drop or two of benzole or turpentine to keep them in place, and when dry, which will be in a few minutes, add a drop of Canada balsam, cover with thin glass, previously just warming the cover, put the slide in a warm place for some hours to harden, and it will then be ready for examination."

I trust that what I have called attention to this evening may prove as much a source of interest to those members who should take up the subject as it has been to myself.*

* After reading the above paper, Mr. Frank Crisp and Mr. Alpheus Smith kindly called my attention to notices in the "Transactions of the Linnean Society," and in "Nature," of two new Freshwater Sponges discovered in Australia, and described by Mr. W. A. Haswell, viz., *Spongilla sceptroides* and *Spongilla botryoides*.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DESCRIPTION OF PLATE VII.

(1) Diagrammatic section of the Statoblast of *Spongilla Carteri,* through the aperture *d*, showing *a*, inner investing membrane; *b*, chitinous coat; *c*, crust, composed in this species of hexagonal cells as fig. *e*.

(2) *a*, Statoblast of *Spongilla Carteri;* *b*, curved, smooth, acerate spicule of same; *c*, curved spinous, acerate spicule of *S. Lacustris.*

(3) *a*, Statoblast of *Meyenia fluviatilis,* showing position of spicules; *b*, birotulate spicule of same; *c*, end view of disk of spicule.

(4) *a*, Statoblast of *Meyenia plumosa*, showing position of spicules; *b*, birotulate spicule of same; *c*, stellate form of spicule of membrane.

(5) *a*, Statoblast of *Tubella reticulata*, showing position of spicules; *b*, inæqui-birotulate, or trumpet-like spicule, of same; *c*, spinous skeleton spicule, forming capsular layer to the statoblast.

(6) *a*, Statoblast of *Parmula Batesii*, showing position of spicules; *b*, parmuliform spicule; *c*, spinous acerate spicule.

(7) Diagrams showing development of spicules.

Remarks on a Paper "On Fluid Cavities in Meteorites" read by H. Hensoldt before the Quekett Microscopical Club on August 26, 1881.

By A. de Souza Guimaraens, F.R.M.S.

(*Communicated November 24th,* 1882.)

I am not aware that any terrestrial rocks have yet been discovered showing structure which might be mistaken for that of a meteorite, the iron masses in the Ovifak Basalts being, perhaps, the only exception on record.

I have placed under one of the microscopes on the table a section of the specimen described in the above paper.

I also exhibit—for comparison—a section of ferruginous quartzite from near Upata, South America, and two sections of quartz (one mounted by Mr. Hensoldt) containing fluid cavities with bubbles which have spontaneous motion.

Upon comparing the so-called "Braunfel's Meteorite" with the quartzite from Upata, the resemblance existing between the two specimens is very striking. One observes great similarity both in the clear grains and the opaque mineral. Under polarised light the two sections do not show any important difference in structure.

The proportion of the opaque mineral compared with the clear grains is greater in the Braunfels specimen than in the quartzite, but this difference, being one of proportion only, is really unessential.

The similarity between the fluid cavities with moving bubbles is more distinctly seen when comparing the so-called "Braunfels meteorite" with either of the quartz sections I exhibit. The fluid cavities and moving bubbles enclosed in the quartzite show the family likeness, but they are less numerous, smaller, and require at least × 500 for their satisfactory exhibition.

As to the metallic lustre, of which Mr. Hensoldt seems to make a special feature, it will be found that the *polished* section of the

Upata quartzite I have placed on the table presents an identical appearance to that possessed by the so-called meteorite.

After reading Mr. Hensoldt's paper, I was for months under the impression—misled by various circumstances—that some meteorites contained fluid cavities with moving bubbles. But I soon became conscious of my error upon acquiring accurate information; hence this communication.

I would also call attention to the fact that Mr. Hensoldt omitted to state in his paper, that the authorities of the British Museum, after examining, not only a section but also a portion of the specimen itself, informed him in December, 1880—eight months before the paper was read—"that the so-called 'Braunfels meteorite' had none of the characteristics of a meteorite, but had those of a *quartzite*; that no one was likely to accept it as a meteorite; that the enclosed mineral was quartz; that the enclosed fluid was probably water; and that the enclosing substance was very probably oxide of iron."

Dr. Sorby writes—"I have examined in a superficial manner one of the specimens . . . and my strong belief is that the clear grains in which they (the fluid cavities) occur are *quartz*, and that the specimen is no meteorite."

As the authorities above quoted are unanimously of opinion that the transparent mineral is *quartz*, it only remains for Mr. Hensoldt to prove his assertion—"The transparent material I have found to be a silicate of the Phenacite group, and closely resembling phenacite in all its characteristics." * If he can prove this he has added, not only a new mineral, but a new element (glucinum) to meteorites.

Professor Judd states—"The minerals which occur in meteorites are in every case such as are found in the more basic volcanic rocks—quartz, and the acid felspars, the other minerals which occur in acid rocks, being entirely absent in the 'extra-terrestrial rocks.'" †

Sections of the so-called Braunfels meteorite were sent to Dr. A. Brezina, of the Imperial Museum, Vienna, but were returned by him with a letter, in which he says "the substance is probably, some furnace product, and has no resemblance to any meteorite known."

* "Journal of the Q. M. C.," Vol. I, Series ii, No. 1, March 1882, page 13.

† "Volcanoes," 2nd edition, page 317.

It is not improbable that meteorites may yet be found containing minerals differing from those already described, but when such discoveries are made they must be substantiated by the strongest evidence, including chemical analysis.

Until then, and in the present state of our knowledge, *any specimen containing quartz or phenacite must be regarded as presumably of terrestrial origin.*

Taking all the above facts into consideration, one is justified in believing that Mr. Hensoldt's theory and conclusions are erroneous.

Further Notes on Fluid Cavities in Meteorites.

By Heinrich Hensoldt.

(*Communicated November* 24, 1882.)

Whatever information I am personally enabled to give respecting the meteorite of Braunfels is contained in the paper on Fluid Cavities, which I read last year before the Club ; and I am afraid I can add but little of value or importance in a possible discussion with experts. Nor am I personally in a position to maintain such a discussion, for I am neither deeply learned in mineralogy nor an authority on meteorites. I can merely render an account of facts as they have been brought before me bearing on this question, and of experiments which may either support or weaken the conclusions I have drawn from them (viz., the facts). The conclusions may be erroneous, but the facts remain; and if the former should be the case I need scarcely apologise to the Club for communicating them in a paper, for the refuted arguments would then acquire a negative value by facilitating the true explanation of the facts.

Since the publication of my paper in the Journal of the Club it has repeatedly come to my knowledge, more as a rumour than in the shape of any distinct information, that such and such an authority had expressed his doubts as to the meteoric character of the specimen described by me as the meteorite of Braunfels. In only two instances am I directly acquainted with the opinions of scientists of repute respecting the subject, which opinions I will mention before proceeding with other observations. Mr. Fletcher, of the British Museum, to whom I had submitted a fragment of the material for examination, stated that in his opinion it was *not* meteoric, and that the substance which I had considered to be metallic iron was in reality Hematite. The custodian of the Mineralogical Cabinet of Vienna wrote to my father that there could be no doubt as to the presence of metallic iron in the specimen, but that in his belief the latter was the produce of a melting furnace of iron-ore, a kind of ferruginous slag, such as might be met with in the neighbourhood of an iron foundry, or be found in

the fields years even after every trace of the foundry had disappeared. Then, indirectly, through the medium of a F.R.M.S. who communicated with Dr. Sorby on the subject, I have been informed that in the opinion of the latter gentleman the so-called meteorite was a species of ferruginous quartz, and that not a single one of the many supposed meteorites which had from time to time been sent to him for inspection, had turned out to be a real meteorite. I have also been told by observers whose opinions are at least worth quoting, that the specimen in question could not possibly be a meteorite, because, apart from the fluid cavities, it presented features which had never before been observed in meteorites, that it was not "like" a meteorite, and that the transparent mineral which I had declared to be Phenacite, or something closely allied to it, was really quartz. A few others have even ventured to express it as their opinion that the mere presence of the *fluid cavities* precluded the possibility of the meteoric origin of the material.

How far these various adverse criticisms are correct, it does not behove me to determine; they must rest on their own merits, and on whatever superior convictions they may carry with them. To gainsay such men as Dr. Sorby and Mr. Fletcher would be looked upon as highly presumptuous on my part, and would certainly not advance my cause. I will therefore content myself in the first place by analysing the more important of the statements contained in my paper, by tracing the conclusions which I arrived at from the facts as they presented themselves to me, and finally I by comparing the opinions of some of the authorities which I have mentioned with mine, and with each other.

To begin with, there are the remarkable circumstances under which the meteoric mass (I must continue to call it so, for in my own mind I am quite satisfied of its meteoric origin) was obtained. Were I in a position to prove beyond the shadow of a doubt the absolute accuracy of the account given in my paper of the discovery of the mass, this would at once and for ever dispose of every argument advanced against its meteoric character. This the most eminent authority on meteorites would doubtless admit. Unfortunately, I am not in such a position, for neither my father nor myself have personally witnessed the occurrence described in the beginning of my paper. And I am afraid that, even if either or both of us had been present, the testimony of an additional pair of

eyes and ears would not have carried much weight against hostile scientific opinion at large. The meteoric mass was brought to my father by a young student of Braunfels, a native of that place, named Otto Müller, who stated that he had obtained it from a shepherd of St. Georgen, a small village, or rather suburb of Braunfels, and who had obtained it under precisely the conditions already described. This shepherd, an old man named Schütz, whom both my father and myself afterwards repeatedly interrogated, corroborated the statement of the student Müller, and at our request accompanied us to the scene of the occurrence, a field on the slope of a hill, about a mile and a half from the town, where the traces of some recent digging were pointed out to us, which we carefully examined, without however, deriving much information from that circumstance, for, apart from the distortion apparently caused by the digging instrument, the rain had softened and altered the appearance of the original depression. I may here remark that my father, before removing to the neighbouring town of Wetzlar, had resided in Braunfels for nearly twelve years, where, owing to his known taste for natural history, the farmers and peasants were in the habit of bringing to him whatever in the way of curiosities they happened to meet with in field or wood, be it plants, insects, or strange-looking stones. We have no reason to doubt the words of the student or shepherd; the material was brought by the former *as* a meteorite, and no reward, pecuniary or otherwise, was claimed or expected.

Starting now from what appeared, and still appears to us, so convincing an evidence of the meteoric origin of the specimen, every further examination of the latter itself, in our eyes at least, confirmed it. Had the substance been undistinguishable from a piece of Basalt or Granite, we should still have been satisfied of its meteoric character, so convinced are we of the accuracy of our information respecting the circumstances of its discovery. But here was an object which, in addition to these circumstances, possessed all the characteristic features of a meteorite, and which was unlike any mineral or rock specimen we had ever seen. It was blackish, heavy, and composed in great part of what surprisingly resembles metallic iron. It was furthermore possessed of that test-feature of true meteorites—a hard *crust*—with numerous sand grains imbedded, pointing to the conclusion that it must have been in a state of fusion. If all these qualities are deceptive, I confess

myself unable to venture a single observation on meteorites, and would warn everybody to leave that delicate subject entirely to experts. My experience in meteorites before I knew of the specimen from Braunfels has at least been a practical one. Dr. O. Buchner of Giessen, who is the author of two works on meteorites, often sent small fragments from authenticated meteorites to my father for the purpose of obtaining sections from them. These mostly passed through my hands, and I was also, while studying at Giessen for one and a half years, a pupil of Dr. Buchner. As regards the opaque component of the specimen from Braunfels, which, as I have described in my paper, is distributed in the shape of a minute network, its true character is still a puzzle to me. That it is not pure metallic iron, as seemed at first to be the case, I have already mentioned in the paper. But I am equally certain that it is neither Hematite nor any other *ordinary* ferruginous combination, for I am not aware that any similar known substance is capable of receiving and *retaining* such an absolutely metallic lustre or polish.

The crystalline and transparent component of the meteoric mass (which contains the fluid cavities) is clearly not quartz, at least not in my humble opinion. The crystals or granules will melt with borax before the blowpipe slowly, and form a transparent glass. They will furthermore dissolve slowly in salt of phosphorus, leaving a skeleton of silica. With a trifling amount of soda they will melt into a white bead, while with a larger quantity they become infusible. The crystalline form appears to be Rhombohedral (37° 19′) and lamellæ cut at right angle to the principal axis show by polarised light the ring system and dark cross. These qualities are certainly not exhibited by quartz. There is only one mineral which possesses similar or identical peculiarities, and that is that singular combination of glucine and silica called Phenacite (Silica 54·90, Glucine 45·10).

I will not add to the length of this statement by rendering a still more detailed account of the circumstances which gave origin to the opinions expressed in my paper on fluid cavities, or by introducing matters not strictly relevant to the subject. Having related in a condensed form the facts, or what *I* look upon as the facts, of the case, and the conclusions rightly or wrongly flowing therefrom, I will again briefly refer to the various opinions of adverse critics which have come to my knowledge. To attempt to

prove that they are in the wrong and myself in the right would be futile with the scientific public at large, at least in this country, where general information is not so diffused, that is, where the knowledge of a *plurality* of scientific subjects is more rarely met with in the same individual, and where the solution of problems not entirely self-evident is habitually referred to known specialists, whose opinion is thenceforward quoted as "law" by the majority. While I would invite every observer who may feel an interest in this subject to think and test for himself, unbiassed by any criticism not resulting from his own research, I do not wish to detract from the merit of opinions already expressed by authorities more or less eminent. But I may point out that at least, those which have come to my knowledge are not characterised by great unanimity. They agree, it is true, in their denial of the meteoric origin of the specimen from Braunfels, but here the comparison ceases, although I should imagine that if they are unanimous in declaring what it is *not*, they should be equally unanimous in establishing what it IS. Between the opinions of Mr. Fletcher, of the British Museum, the custodian of the Mineralogical Cabinet of Vienna, and Dr. Sorby there is a marked discrepancy, for one considers the opaque substance in the specimen to be Hematite, another metallic iron, and the entire mass the produce of a melting furnace, and the third (if I am rightly informed) a kind of ferruginous quartz. I am also of opinion that it is entirely fallacious to establish the possibility of the occurrence of the one or the other substance in a meteorite by comparison with what is known of the composition of *other* meteorites. If we regard the countless myriads of meteorites which are known to traverse space, and which most probably present a vaster diversity of mineral combination in the aggregate than exists on this globe; and if on the other hand we consider the isolated few which have happened to fall on the earth, it appears in my eyes an absurdity if, from the accidental composition of the latter, we were to determine what is possible and what is not possible in a meteorite.

Respecting the fluid cavities, I may mention that shortly after the publication of my paper, M. A. de Souza Guimaraens, F.R.M.S., who happened to possess a number of meteoric sections, some by well known mounters, such as Möller, but which he previously had never thought of carefully examining with high powers, found fluid cavities with bubbles in continual motion in nearly every one of

them. He was kind enough to submit them to my inspection, and I certainly observed the phenomenon in four out of five sections, one being from a fragment of the well-known meteorite of Pultusk. I do not know in how far the meteoric character of these sections was established, but besides having been procured from esteemed and well-known mounters, they presented the appearance of genuine meteorites.

In conclusion I will also draw attention to the fact that, when Dr. Hahn, not two years ago, made known his discovery of organic remains in material of meteoric origin, he was fiercely attacked, and most of the critics, especially in this country, derided the very possibility of such a discovery. Now, after prolonged and careful investigation, the meteoric character of the substance has been established, and the truth of the other assertions is all but generally acknowledged.

On Mounting in Glycerine, and on Making Cells of Thin Glass.

By Dr. H. T. Whittell, M.D., F.R.M.S.

(*Read December* 22, 1882.)

The working microscopist frequently meets with objects which he would gladly preserve, but which, having been prepared only for immediate observation, and lying under the cover-glass floating in a drop of water or glycerine, with a quantity of the same fluid on the slide outside the cover, are not easily surrounded with a coating of impervious cement, so as to be secured as permanent preparations. If the worker attempt to raise the cover, and to remove the preparation to a ringed slide, he is almost sure to lose his object, or so to disarrange it that it is of no further use. If he apply pressure to hold on the cover while he cleans away the superfluous liquid, he produces a sort of microscopical squash, much delighted in by dealers in insect preparations, but which is spoiled for all instructive uses.

Glycerine can always be floated under preparations of this kind, by the usual plan of applying bibulous paper on one side of the cover and a drop of glycerine on the other; but however carefully this be managed, the uncovered part of the slide becomes more or less smeared with the glycerine, which it is extremely difficult or impossible to remove, so as to get a good adhering surface for the cements usually employed for securing a permanent mount. It is, of course, easy enough to mount in glycerine when a preparation is placed on a ringed slide and the cover-glass has been edged with cement, or even when a preparation can be placed so that just sufficient glycerine can be applied to run to the edge of the cover and no farther; but in the every-day student life of real work these precautions cannot be taken, and what is wanted is an effective plan for removing superfluous liquid and binding down a cover-glass over an object in the exact condition in which it has been found. During many years I have tried all the plans and cements that in the course of my reading I have found recommended. Now

and then some of them have given me a valued slide, but until lately I have not found any plan upon which I could rely with the same certainty as when mounting in a ring. Perhaps the best results have been obtained from passing a layer of very thick mucilage along the edges of the cover. This mixes with the glycerine, and, in dry weather (like the summer in Australia), the whole sets with sufficient firmness to receive coatings of a more durable cement. Coaguline applied warm has also given me fair results—say in half the cases tried. The difficulty with both these fluids is, that they retain some quantity of water after setting, and this is apt to cause the covering cements to peel off. I have lately obtained much more satisfactory results, by a simple process which I venture to ask the Club to assist in testing.

As much glycerine as possible is first removed from the slide by the usual plan of wiping, and absorbing with bibulous paper round the edges of the cover. A little gold size—that sold to artists is best—is rubbed up with a little whiting that has been previously well dried in an oven, and this is poured into a bottle for use. Some of the whiting settles to the bottom, but a quantity is held in suspension, and a larger proportion can always be obtained by shaking up the bottle. By means of a fine brush a little of this chalk cement is passed along the edges, and just outside the cover-glass, taking care to fill up the angle between the slide and cover. To prevent moving the preparation, it is better in this stage to imitate, what the artists call "stippling," than to take the brush along in one sweep. The cement falls from the brush as one proceeds, and it is easy to see when enough has been applied. In my own practice, while taking care to have sufficient cement to fill up the angles, I aim at having as narrow a line as possible around the edges of the preparation. The slide is now set aside for twelve or twenty-four hours, when the layer of cement will have become tough, and will be found to hold the cover effectively in its place. The slide is now put into water to wash off all trace of glycerine, and is afterwards set on end to drain and dry. A ring of gold size or other cement may afterwards be applied in successive layers, and in due time, when all is firmly set, a finishing layer of white cement or of asphalt may be applied.

I have now many slides prepared as described, and I seldom fail to preserve anything I wish. As an illustration, I may mention a rather severe test in which the plan answered admirably. I had

dissected for study the viscera of a blow-fly, and I found on my slide all the parts, from stomach to termination of intestine, the kidney tubes, liver tubes, oviduct, and several ova, all well displayed *in situ*—an object worth preserving. I knew that the slightest movement would disarrange the specimen, and pressure would ruin it. The ova and lower part of the intestine are rather thick objects for mounting without a cell, but the chalk cement filled up the angles between the cover and slide so effectively that I had no trouble in obtaining a firm and permanent specimen for my cabinet.

When I was in London I wished to mount some Polyzoa in cells made from rings of thin cover glass, but was unable to purchase such rings except at a price which was prohibitory to their use in large quantities. I was told the trouble of making them was so great that it would not pay to sell them at lower rates.

Dr. Beale's plan of making these rings, by fastening a cover-glass on a metal ring with melted marine glue, and afterwards knocking out the centre with the end of a file, remelting the glue to loosen the ring, and afterwards cleaning it off, is a troublesome time-taking process. After experiment, I find that thick gum mucilage may be substituted for the marine glue, and that the cells can then be made with great ease.

Take any number of the thicker glass rings or squares used for making microscopical cells, fasten on each a piece of cover-glass by means of gum mucilage, let them stand in a warm place from 24 to 48 hours, till the gum is firmly set. After this break out the centres as in Dr. Beale's method; the part of the thin glass fastened to the rings will remain intact. It is well, as a precaution, to scratch round the inside of the ring with a writing diamond before knocking out the centre. If desired, the inside edge of the ring may now be smoothed with a fine file; but I believe the ragged edges are an advantage in giving greater firmness to the adhesion of the glass in its after uses. The centres being cleared, the whole are thrown into water and left there for a few hours. After which, the gum being dissolved, the thin glass rings will be found loose, clean, and ready for use. The beginner will probably break a few pieces before he acquires the knack of clearing the centres, but after a little practice nine out of twelve will remain perfect. Thick rings with broad edges will be found best to commence with.

PROCEEDINGS.

August 11, 1882.—Conversational Meeting.

The following objects were exhibited :—

Sphæraphides in Chickweed leaf, polarized ...	Mr. F. W. Andrew.
Daphnia Schafferi, with parasitic rotifers, Palate of Black Slug	Mr. H. R. Gregory.
Early stages of embryo of the Chick, specimens prepared by Prof. Fritz Meyer, and presented by the Dinner Committee	The Club Microscope.

Attendance—Members, 22; Visitors, 0.

August 25th, 1882.—Ordinary Meeting.

Dr. M. C. Cooke, M.A., A.L.S , President, in the chair.

The minutes of the preceding ordinary meeting and of the 17th annual meeting were read and confirmed.

The following gentlemen were balloted for and duly elected members of the Club :—Mr. W. H. Field, Mr. T. J. Gibbs, Mr. Christopher Jackman, Mr. George Powell, and Mr. T. Williams.

The following additions to the Library were announced.

" Proceedings of the Linnean Society " ...	From Mr. T. C. White.
" Journal of the Royal Microscopical Society "	,, the Society.
" Transactions of the Essex Field Club ...	,, ,,
" Proceedings of the Belgian Microscopical Society "	,, ,,
" Science Gossip "	,, Publisher.
" The Northern Microscopist "	,, Editor.
" American Naturalist "	In exchange.
" American Monthly Microscopical Journal "...	,, ,,
" Kent's Infusoria " Part 6	By subscription.
" Quarterly Journal of Microscopical Science "	Purchased.
" Annals of Natural History "	,,
" Micrographic Dictionary." Part 14 ...	,,
" Bowerbank's Sponges." Vol. 4	Ray Society.
" Cooke's Fresh Water Algæ "	Purchased.

The thanks of the meeting were unanimously voted to the donors.

A photograph of Mr. J. W. Meacher was presented for the Club Album.

The Secretary called the special attention of the members to the valuable donation from the Dinner Committee, which, although announced at the last meeting, was not sufficiently noticed at the time from pressure of other matters. It consisted of a series of specimens of sections of the embryo of the chick, prepared by Prof. Fritz Meyer, at the Zoological Station at Naples, the study being the direct outcome of a visit from Prof. Balfour. They were all very early stages, and though the exact periods were not given, as the specimens were numbered, no doubt the particulars could be ascertained; but the most advanced was of very much earlier age than those which were generally to be got. He was sure that the Club would feel very much indebted to the Dinner Committee for making them a gift of so interesting a character.

Mr. Michael thought there was no doubt as to their being able to get the exact date of the periods of incubation; the practice being always to have every specimen numbered with reference to records made at the time. Observations of this kind had been also made upon the embryo of the Goby, of which a series of 35 had been prepared, and in every instance the exact period had been noted. He only regretted that they should not be able to get any more like them, as Dr. Meyer had ceased to mount them.

The President read an account of some observations which he made some years ago, as to the number of *Foraminifera* found in a given quantity of chalk, confirmatory of the previous estimates by Ehrenberg.

The President called attention to the following opinion announced by Pringsheim* of the functions of the radiating protoplasmic threads from the nucleus in the cells of *Spirogyra*, a drawing being made upon the blackboard. "An anatomical fact, hitherto unrecognized in the organization of *Spirogyra*, may here be noticed. The threads of protoplasm extending outwards from the central plasma mass in each cell do not, as was supposed, end in the general protoplasmic lining of the cell wall, but each passes directly or by its branches to the internal surface of a chlorophyll band, and there dilates in a trumpet-like manner, and grasps, as it were, an amylum-body. If, as sometimes occurs, there is no amylum body visible at the point where the thread is in contact with the chlorophyll-band, the spot may be considered one where such a body will subsequently appear. As the amylum-bodies increase by division, the grasping protoplasmic thread also divides by forking, and thus each daughter amylum-body is grasped by a protoplasmic thread; and, on the other hand, the protoplasmic threads may divide in the first instance, and a new amylum-body is subsequently formed in the chlorophyll-band at the extremity of the new protoplasmic thread. As an outcome of this mode of increase, the adjacent amylum-bodies are often connected bridgeways by threads of protoplasm; and as longitudinal division of the chlorophyll-bands often proceeds synchronously with the multiplication of the amylum-bodies and the forking of the protoplasm threads, the amylum-bodies so connected may be in different spires of the

* "Pringsheim's Researches on Chlorophyll," p. 81.

chlorophyll-band. In the angles of the forks of the branching protoplasmic threads there is usually visible, in strongly growing *Spirogyra* filaments, a thickening of the substance of the thread in which a vesicle, perhaps a kind of amylum-body, lies. There is then, in *Spirogyra*, a direct connection through the threads between the amylum-bodies themselves, and also between them and the nucleus."

Mr. Michael called attention to a slide which he had brought for exhibition of a specimen of the genus *Nothrus*, the individuals in which were not so highly chitinized as in some genera nearly allied to them—the leathery cuticle existing in the adult. Being thus deprived of their ordinary means of defence, it was curious to notice what other means were taken for the protection of their bodies. As a rule the *Oribatidæ* had rounded arched bodies upon which nothing would lodge, but in the particular genus mentioned the body was chiefly oblong or square, and flat or concave, it was also furnished with a number of curved hairs, which effectually prevented dirt from falling off, so that these creatures were in the habit of carrying about a quantity of earth upon their backs, which concealed and protected them from their enemies.

Votes of thanks to the President and to Mr. Michael were unanimously passed.

Announcements of excursions, &c., for the ensuing month were made, and the proceedings terminated with the usual conversazione, at which the following objects were exhibited :—

Hydrodictyon utriculatum Epistylis anastatica	Mr. J. D. Hardy.
Nothrus spiniger...	Mr. A. D. Michael.
Section of the Meteorite that fell at Ensisheim Nov. 7, 1492	Mr. Geo. Smith.

Attendance—Members, 30 ; Visitors, 1.

September 8, 1882.—Conversational Meeting.

The following objects were exhibited :—

Hairs on petal of Pansy	Mr. F. W. Andrew.
Polyxenus lagurus	Mr. A. L. Corbett.
Cyclosis in *Nitella flexilis*	Mr. H. G. Glasspoole.
Lagena sulcata, from Dog's Bay, Ireland ...	Mr. H. Morland.
Navicula rhomboides, in balsam, shown by Powell and Lealand's oil-immersion 1-25th objective N.A. 1·38, with dry achromatic condenser, direct light and full aperture	Mr. E. M. Nelson.
Lingual teeth of *Aplysia leporina*	Mr. J. J. Vezey.

Attendance—Members, 32 ; Visitors, 2.

The 200th Ordinary Meeting.—September 22nd, 1882.

Dr. M. C. Cooke, M.A., A.L.S., &c., President, in the Chair.

The minutes of the preceding meeting were read and confirmed.

Mr. Wm. H. Mills and Mr. George Moore were elected members.

The following additions to the Library and Cabinet were announced, and the thanks of the meeting voted to the respective donors:—

"Proceedings of the Royal Society"	From the Society.
,, "Norfolk and Norwich Natural History Society" ...	,, ,,
"Proceedings of the Belgian Microscopical Society"	,, ,,
"116th Report of the Chester Natural History Society"	,, ,,
"Science Gossip"	,, the Publisher.
"Northern Microscopist"	,, ,, Editor.
"American Naturalist"	In Exchange.
"American Monthly Microscopical Journal"...	,, ,,
"List of Foreign Correspondents, Smithsonion Institution"	From the Institution.
"Micrographic Dictionary." Part 15 ...	Purchased.
"Annals of Natural History"	,,
"Cooke's Fresh Water Algæ"	,,
"Grevillea"	,,
"Cole's Studies in Microscopical Science" ...	By Subscription.
"Cameron's Phylophagus Hymenoptera," Vol. i.	Ray Society.
"Challenger Reports," Vol. v.	Purchased.
One Slide...	Mr. H. G. Glasspoole.

Mr. J. D. Hardy exhibited and described a gas lamp for microscopic use, which was an adaptation of the Albo-Carbon burner to a table lamp-stand.

In reply to a question from Dr. Matthews, Mr. Ingpen explained that the substance known as Albo-Carbon was common crude Napthaline, which was deposited by condensation in the gas mains in cold weather, causing stoppages of pipes, &c.; the gas burner known by this name was a contrivance for restoring this element to the gas, and to some extent super-carburetting it at the burner.

Mr. Badcock said the saving of gas would more than compensate for the extra cost of burner and carbon, as a better light could be got in this way with a No. 1 burner than with ordinary gas and a No. 7. With proper care there was no smell with it to any extent.

Mr. E. M. Nelson exhibited and described an arrangement for facilitating the fixing of objectives to nosepiece of microscope.

Some discussion as to whether the idea was new then took place, during

which it was stated to have been suggested some years ago in "Science Gossip."

Mr. Nelson said that Dr. Morris, who was now in England from Australia, and had been searching all over the country for diatoms, had at length met with the object of his search in a very fine gathering of *Amphipleura Pellucida*, some of which was exhibited in the room.

Dr. Ralph expressed his desire of making communications and exchanges with the Society on his return to Australia. Also that if any more of the exuviæ of Larvæ, such as he brought to the last meeting of the Club, were required he would send a supply, though he feared that the lowness of temperature added to the risk of injury in the transit might be unfavourable to development. He also left a pamphlet on the subject at which he had been working for some years, "On experiments with the blood and the mode of chemicalizing it."

The thanks of the meeting were voted to Dr. Ralph.

Mr. Priest called attention to some notes of Prof. Moseley's on Pelagic Life, which he recommended to the perusal of those who were interested in the subject.

Mr. Ingpen read a paper by Herr Carl Zeiss "On the method of using Prof. Abbe's test plate."

Mr. Karop read a paper "On a method of showing *Bacillus*," by Dr. Heneage Gibbes.

The thanks of the meeting were returned to readers of papers. The engagements for the ensuing month were announced, and the proceedings concluded with the usual conversazione, at which the following objects were exhibited :—

Sections of White Coral, transverse and longitudinal	Mr. F. W. Andrew.
Stentors	Mr. E. Dadswell.
Alcyonella Van Bedeni	Mr. W. Goodwin.
Dr. Morris's *Amphipleura pellucida* × 1200 diam., shown by oil-immersion 1-12th N.A. 1·42, direct light without stop ...	Mr. E. M. Nelson.
Section of Butcher's Broom, stained	Mr. F. Oxley.
Spherical crystals of Inuline in sections of root of *Taraxicum* and tuber of *Dahlia*	Mr. J. W. Reed.

Attendance—Members, 51 ; Visitors, 3.

October 13, 1882.—Conversational Meeting.

The following objects were exhibited :—

Fungus on leaf of Horseradish	Mr. F. W. Andrew.
Seed of *Collomia grandiflora*, showing the spiral fibres of the seed coat... ...	Mr. E. Carr.
Tachina spinipennis, showing the curious sexual organs	Mr. H. E. Freeman.
Sections of Spines of Echini	Dr. Matthews.
Various test-objects shown by Messrs. Powell and Lealands new oil immersion $\frac{1}{12}$ objective, N.A. 1·42	Mr. E. M. Nelson.
Wing of an Alpine Moth	Mr. J. M. Offord.
Section of stem of *Viburnum lantana*, double-stained	Mr. J. W. Reed.
Slightly enlarged photographs of Microscopical objects, printed by the platinotype process	Mr. Washington Teasdale.
Calcareous Sponges	Mr. J. G. Waller.

Attendance—Members, 53; Visitors, 6.

October 27th, 1882.—Ordinary Meeting.

Dr. M. C. Cooke, M.A., A.L.S., President, in the Chair.

The minutes of the preceding meeting were read and confirmed.

The following gentlemen were balloted for and duly elected members of the Club :—Mr. Fredk. Wm. Brown and Mr. Edgar Thurston.

The following donations to the Club were announced :—

"Proceedings of the Royal Society"	From the Society.
" " "Postal Microscopical Society"	" "
"The American Naturalist"	In exchange.
"The American Monthly Microscopical Journal"	" "
Dr. Cooke's "Myxomicetes"	
"Proceedings of the Belgian Microscopical Society"	From the Society.
"Dr. Ralph's Micro-Chemical experiments on Blood," &c....	" the Author.

"Challenger Reports," Vol. v....	Purchased.
"Catalogue of Fossil Foraminifera in British Museum"	"
"Annals of Natural History"	"
"Coles' Natural History Studies," 19 to 24 ...	"
"Dippel's Treatise on the Microscope" ...	"
Two Slides of Diatoms	From Dr. Partridge, of Stroud.

The thanks of the Meeting were voted to the Donors.

Mr. E. M. Nelson exhibited and described Zeiss's dissecting microscope.

Dr. Ramsden enquired whether the instrument was capable of resolving the striæ on Navicula Lyra into dots?

Mr Nelson said no; but it would show the striæ.

Mr. Ingpen could fully confirm all that Mr. Nelson had said as to the merits of these lenses, having been in the habit of using them for some time. He had not seen the low power one before, but welcomed it as a very useful addition to the series. He had always advocated the use of good lenses where low powers were required, although often told that a common watchmaker's eye-glass was all that was wanted for dissecting purposes; theoretically, however, it could be proved that an achromatic lens was necessary, and he thought they were much indebted to Mr. Zeiss for bringing out lenses of this kind, and thus enabling them to save their eyes as much as possible. With his own defective vision he found he could do ten times the work with one of these lenses that he could with a common glass, and he was quite sure that there was a very great saving of the eyes in using glasses of this sort.

Mr. T. C. White inquired what was the working distance in the case of the smaller of the two microscopes exhibited, because if it were only a $\frac{1}{4}$in. or even $\frac{1}{2}$in., he thought it would be rather difficult to work under. He quite agreed with the opinion that it was a necessity to have good lenses to dissect with. He had lately been using Stephenson's binocular with its erecting prism, and being engaged on a paper upon the salivary glands of insects, he had been making a number of small dissections, such as the salivary glands of a flea, and the importance of getting the object near to the head was very much impressed upon him—if it was a long way off the operator was very apt to get the needles in the wrong place.

Mr. Nelson said that the focal distance of the lens was $\frac{3}{10}$in. with the eyepiece, and gave a power of 100. Without the eyepiece the focus was considerably shortened, although the power was reduced to about 20. A watchmaker's lens of the same power would be considerably shorter.

Mr. T. C. White asked if the lens gave a good field of view? He thought the requisites for a dissecting microscope were a good field, good definition, and that the object should be near at hand.

Mr. Ingpen said at first sight the field seemed to be extremely small, but if the eye were put close down to the eyepiece it would be found that by looking sideways a good sized field could be obtained. If they wanted to

dissect with a power of 100, they must of necessity be manipulating with very small points, and in a very small space. These lenses were made in several forms and with various powers, but no one should give them up because they seemed to have such small fields.

Mr. Michael said he should not like Mr. White's remark to go out as to Stephenson's binocular without some qualification. He had used it himself for insect dissection, and could only say that he found the relative distance between the head and the hands to be a matter of the greatest possible comfort. He had worked in this way with a Siebert ½in. of very much shorter focus than an English ½in., and he did not think he could possibly have done it with the head so near the hands as in the little instrument before them. It was a most charming little instrument, but for fine dissections he thought it was not so convenient as the Stephenson. The binocular arrangement was also a great comfort to the eyes, and was very useful in giving a notion as to whether an object was above or below another in the field; although it did not profess to be stereoscopic, practically it was so; the large flat stage was also very convenient.

Mr. T. C. White said he did not wish to give rise to any false impressions as to the value of the Stephenson binocular. On the contrary, he liked it exceedingly, and the only thing he felt disposed to object to was its large size. Of its value as a binocular there can be no doubt whatever.

Mr. Sigsworth said it appeared to him a question whether the invention of the larger form exhibited could be credited to Zeiss, for he had one himself by Chevalier made thirty years ago which seemed to be exactly the same.

A paper by Mr. J. W. Morris, F.L.S., of Bath, "On the fibro-vascular bundles in Ferns, and their value in determining affinities of genera," was read by Mr. Curties.

The President said that it should be borne in mind that the assertions made in the early part of the paper would apply equally to all other classes included in the study of Botany. It was true no doubt that Linnæus gave a generic name to a certain set of plants, and that ten years afterwards some one else gave another name to the same, so that it happened in the course of half a century that they got a number of synonyms, each accurate enough in its way, according to the light which the observer had at the time he was writing, and which justified him in discarding the classification adopted by those possessing less light who had gone before. This, however, did not prove that the student of the present day was consequently justified in entirely altering the plan upon which all classification had hitherto been based, and he did not see that the proposal applied more to Ferns than to any other branch of Natural History. As to the value of adopting a plan based upon peculiarities of structure, such as was recommended in the paper, it would be found incontrovertibly that such a plan would be of no use for the purpose, and that certainly it would be of no use to propose to classify Ferns in this manner whilst it was not equally applied to other structures. At present the great and primary position was that in which

the fruit held the first place, so that Ferns were accordingly classed with reference to the positions of the sori. It generally happened that when specimens were sent from abroad to be examined and named at Kew, they only got a portion of the frond, and this was enough, but in future, if this plan were adopted, they would have to write and say to correspondents abroad, "It is of no use to send us your oak leaf or acorn, we can do nothing with them. You must send us a section of the stem of the tree on which they grew." He had known many other instances in which similar suggestions had been made, and he knew also how they appeared to practical men. This suggestion had itself been mooted before, but they had come to the conclusion that however useful it might be to have an acquaintance with these features of structure, they were not of any use as a means of classification. Then, if they were to adopt the idea of classifying according to these "spread eagles" found in cross sections, it must be remembered that they differed in appearance in different portions of the stem; which portion, then, were they to adopt? Should it be 6in. high? or half way up? or where? And in the face of this difficulty he thought that what was uncertain could hardly be relied upon as a method of classification. They were, nevertheless, much indebted to the author of the paper for many of the suggestions which it contained, and certainly for the very excellent sections and figures with which he had illustrated the subject.

The thanks of the meeting were voted to Mr. Nelson and Mr. Morris for their communications, and to Mr. Curties for reading the paper.

Announcements of Meetings for the ensuing month were then made, and the proceedings terminated with the usual Conversazione, at which the following objects were exhibited :—

Stellate hairs from leaf of Olive	Mr. F. W. Andrew.
Sections of Fern-stems, showing fibro-vascular bundles, in illustration of Mr. Morris's paper...	Mr. T. Curties.
Nothrus theleproctus, showing the mode of carrying the cast dorsal skins ...	Mr. A. D. Michael.
Carboniferous Limestone, from *Microzoa* Bed, Clifton	Mr. G. J. Smith.

Attendance—Members, 56; Visitor, 1.

NOVEMBER 10, 1882.—CONVERSATIONAL MEETING.

The following objects were exhibited:—

Leaf and flower of *Verbena*, showing glandular and beaded hairs	Mr. F. W. Andrew.
Tube of Marine Annelid	Mr W. R. Browne.
Wing of a Butterfly from Madagascar ...	Mr. A. Button.
Ovaries and Stinging Organs of Wasp ...	Mr. F. Fitch.
Organs of Mouth of Parasitic Bee, *Melecta punctata* mounted sideways, and in their natural position	Mr. H. E. Freeman.
"Kieselguhr" Flint mud from Hanover; used for making Dynamite; containing a new species of *Cyclotella*, called by Mr. Kitton *C. minuta*	Mr. H. G. Glasspoole.
Larva of *Coccinella*	Mr. A. D. Michael.
Cartilage from ear of Mouse, stained	Mr. H. Morland.
Amphipleura Daniea, in checks, shown with $\frac{1}{12}$ oil-immersion objective N.A. 1·43 Human Spermatozoon (preparation by Mr. Heneage Gibbes), showing a division in the tail	Mr. E. M. Nelson.
Statoblasts of *Meyeni plumosa*, Bombay ...	Mr. B. W. Priest.
Leaf of *Rosmarinas*, vertical and horizontal sections ... ... Vertical section of Lavender ... ... Winged peduncle of *Tilia europœa*	Mr. J. W. Reed.
Laomedea, with tentacles expanded	Mr. G. Sturt.
Lophopus crystallinus	Mr. J. G. Tasker.
Hymeniacidon macilenta, a silicious Sponge, showing the mode in which the spicules are arranged in fasces ... ... *Raphiodesma sordida*	Mr. J. G. Waller.

Attendance—Members, 59; Visitors, 5.

November 24th, 1882.—Ordinary Meeting.

Dr. M. C. Cooke, M.A., A L.S., &c., President, in the Chair.

The minutes of the preceding meeting were read and confirmed.

Mr. Thomas Carr was balloted for and duly elected a member of the Club.

The following donations to the Club were announced:—

"Proceedings of the Croydon Microscopical Society"	From the Society.
"Journal and Annual Report of the Braintree and Bocking Microscopical Society"	" "
"Science Gossip"	" Publisher.
Reprint of paper by Rev. L. J. Mills and Mr. Kitton "On Diatoms in Peruvian Guano"	" Authors.
"Proceedings of the Belgian Microscopical Society"	" Society.
"The American Monthly Microscopical Journal"	In exchange.
"Coles' Studies in Microscopical Science," Nos. 25-28	By Subscription.
"Annals of Natural History"	Purchased.
"Micrographic Dictionary." Part 15... ...	"
"Braithwaite's British Moss Flora"	The Author.
24 Slides, Diatoms	Mr. Kitton.
12 Slides, Sections of Stems of Ferns... ...	Mr. Morris.
Six Slides, Statoblasts of Fresh Water Sponges	Mr. Priest.

The thanks of the meeting were voted to the Donors.

The President announced that the Committee had been enabled to arrange for a series of six illustrated demonstrations, to be given on Gossip Nights in class-room No. 8, the list of which he read to the meeting.

Mr. Hailes read a letter received from Mr. Kitton, explaining some notes which accompanied the slides presented.

Mr. Priest read a paper "On the Statoblasts of Fresh Water Sponges," which he illustrated by numerous diagrams and slides.

Mr. J. G. Waller expressed the pleasure he felt at hearing the paper read, and to which he had little to add. Respecting the variations in the Spongilla Fluviatilis, he was very glad to find that there was a new classification, for in Dr. Bowerbank's volume a new species was mentioned as having been found in the river Exe; but he could only say that if species were to be named on this principle, at least six new species might be found in the river Thames.

Votes of thanks to Mr. Kitton and Mr. Priest were unanimously carried.

Dr. T. Spencer Cobbold said he had brought for exhibition some specimens of *Limnea Truncatula.*

Mr. Guimaraens read a paper in which he criticized the statements made by Mr. Hensoldt in a paper printed in the Journal of the Club "On Fluid Cavities in Meteorites."

Mr. Hailes read the rejoinder by Mr. Hensoldt to Mr. Guimaraens' remarks.

Dr. J. D. Brown said he wished to say a word before the matter was closed, as he had himself introduced Mr. Hensoldt, and knew that he had the specimen referred to for a long time before he found the bubbles. The section and also a portion of the Meteorite were there in the room, and if they had sufficient experts present to form a small committee, he thought it might be a good way of settling the question.

Mr. Guimaraens was about to offer some further observations, when

The President, intervening, suggested that as there seemed to be some degree of personal matter mixed up with the discussion, it would be undesirable to prolong it. The appointment of a committee was hardly within their province, and the question was not one upon which they felt called upon to decide.

Mr. Ingpen said that in the course of some correspondence on the subject there had been some doubt as to the date. He would therefore state that it should have been March 19, 1878, and not 1879, as originally stated.

The President, on appeal to the feelings of the members on the subject, decided to close the discussion, and votes of thanks to Dr. Cobbold, Mr. Guimaraens, and Mr. Hailes for their communications, were unanimously carried.

Attendance—Members, 70; Visitors, 5.

December 8th, 1882.—Conversational Meeting.

A demonstration was given in one of the class rooms by Mr. J. W. Groves, F.R.M.S., on "The History of a Stained Section of an Animal Structure." Commencing with the material, which he said should be obtained as fresh as possible, Mr. Groves passed rapidly through the various stages of preparing the specimen, carrying out as far as practicable the whole process before the meeting.

The first step was, he explained, to properly harden the specimen. Many people failed in this, either by putting the fresh material into too strong a fluid, which hardened the surface without penetrating, or they did not get the material sufficiently fresh, and which had therefore undergone morbid changes before being placed in the preserving fluid. Again, with too large a lump of material the outside alone would be hardened.

Mr. Groves then described the various hardening media and the proper strengths of each. The material he said should not be placed at once in strong alcohol, but first in say 65° for 24 hours, then transferred to stronger. The hardening fluid should be changed frequently—at the end of a fort-

night the specimen would be well hardened—and should be transferred to alcohol. The material should be cut into tolerably thin slices in suitable directions, not cutting quite through the lump. The material placed in a piece of net or gauze or antiseptic bandage is then to be hung in a bottle filled with the hardening fluid, so as to keep the material from touching the bottom, or it might be attached to a piece of string with the label hanging outside, thus permitting any refuse to drop to the bottom of the bottle leaving the specimen clean. (Specimens were handed round ; some properly, others not properly hardened.)

The next step was to place the specimen in preserving fluid. The best fluid for this purpose was spirit of 95°.

When cutting by hand, or with some of the section cutters, it was necessary to embed the specimen in a mixture of equal parts of wax and oil. A small paper boat half filled with this mixture being provided, the specimen (if in alcohol, first getting rid of the spirit by a few minutes' exposure to the air) is to be dipped into the wax and allowed to fall to the bottom ; a drop of wax being first formed to serve as a pedestal, to keep the material from falling quite to the bottom, the end of the boat in which the specimen is placed should be marked, otherwise it might happen when the mistake was discovered nothing would remain to hold the specimen when cutting. Another plan was to use a short tube with a cork at the end, but this was not so certain in its operation.

Mr. Groves then introduced and described several forms of microtome, one being practically the original Sterling microtome, which he had described to the Club, with Dr. Matthew's improvements. The wooden plug in this machine prevented any rocking or rotation of the wax. The razor best adapted for use with it was one with a straight *edge*. The blade need not be flat, but it must have a straight edge. The motion in cutting should not be a sliding or pushing cut, but a sort of rotating cut. The direction in which to make the cut was determined by the material which only experience could give. With freezing microtomes it was necessary to get rid of the alcohol. Take a small piece of the material not more than $\frac{1}{8}$inch thick, leave it in water for 24 hours, transfer to gum mucilage with a trace of camphor water (five drops of water to an ounce of gum) to prevent the gum freezing into a hard mass like ice, which would chip the razor. The gum would freeze into the consistency of hard cheese.

In preparing the mixture of ice and salt the ice must be thoroughly pounded, first with the ice prick, then with a mallet, until it was a perfect powder. This must be thoroughly mixed with an equal quantity of salt.

Dr. Pritchard's machine was very portable and efficient. To use it the cylinder was placed in a bowl of ice and salt, the specimen being placed on the top of the cylinder with a little gum mucilage and the felt cap put on. When frozen the cap was placed on the other end of the cylinder which then served as a handle.

In cutting specimens embedded in wax and oil the razor must be kept constantly wet, spirit was preferable for this purpose, and should be placed

in tall narrow jars, care being taken not to damage the edge of the razor in withdrawing it. The razor should be held in much the same way as in shaving. If cutting without a machine the material should be held firmly but lightly.

In Stirling's microtome the trough was not nearly large enough. It should be filled with the freezing mixture and some material wrapped round it. Mr. Groves considered the original Williams' microtome the best form of any. It was necessary to keep the material thoroughly covered with gum. It was also necessary to fill the space between the two surfaces with freezing mixture so as to ensure rapid freezing.

In order to remove the sections from the razor, a very thin and flexible artist's spatula answered well, and the sections should be placed in spirit. If frozen in a Williams' machine they should be placed in a little cold water. It was better not to touch the specimen at all. If provided with a large shallow dish, the top of the machine might be taken off and the sections floated off ; warm water was preferable to cold, as it dissolved the freezing mixture more rapidly, and there was less danger of the specimen getting torn or damaged.

In the ordinary form of the ether freezing microtome, the ether spray was directed upon the brass plate. In the form he was using provision was made for getting rid of the fumes of ether, and was adapted for cutting thick or thin lumps of material. Small thick glass salt cellars were very useful for clearing specimens in clean water.

Mr. Groves then proceeded to cut some sections of spinal cord, remarking that it was essential to get the razor perfectly level or the sections would not be parallel. To test the level, the two ends of the razor were tested until the two cuts were exactly parallel.

As to the thickness of the section he observed the facility with which extremely thin sections could be cut. It was possible to cut sections so thin that they would not hold together. The best thickness was a cell or a cell and a half thick. With practice it was possible to cut as thin as that with Pritchard's machine which was practically cutting by hand. A charming feature of Williams' machine was the marvellous speed with which it could be used, and the facility it afforded for removing one specimen and replacing it by another was of great advantage.

Mr. Groves then cut a number of sections with great rapidity, and placed the sections at the disposal of those members who might wish to have them. He then went on to observe that the next step was to preserve the sections. For this purpose it was necessary to leave the sections in the trough until the gum was dissolved out. If embedded in wax less time would be sufficient. If the sections rolled up in cutting, by transferring them to water for a little time and replacing them in spirit they would float out perfectly flat.

Staining was then illustrated and explained. Staining fluids were of two kinds, alcoholic and aqueous. Logwood and aniline blue-black were very good stains, but it was necessary to get rid of every trace of spirit. The most useful stains were Beale's carmine, pink carmine, logwood, aniline blue-

black, Nicholson's magenta, eosin, Picra carmine, gold, and nitrate of silver. These would stain almost anything. Almost any of them could be used, first one and then another. Mr. Groves then described the preparation of the carmine stain and also the logwood stain, which he considered easy to prepare, though some persons found it difficult. The aniline dyes were also useful. It was necessary, however, to use some of the stains on perfectly fresh material. The gold and nitrate of silver especially required the specimen to be very fresh. If it was removed from the body more than twenty minutes it was useless to use those stains.

When the specimens were in water it was necessary to dehydrate them. If good specimens were desired, it was necessary to use first weak alcohol, then stronger.

The next step was clearing the sections, but if they were to be mounted in glycerine this process was not necessary. The best fluid for clearing was oil of cloves for specimens intended to be mounted in balsam.

In glycerine mounting absolute cleanliness was required. It was best to transfer the section into dilute glycerine, then into stronger. He preferred placing the object in a watch-glass, adding a few drops of glycerine now and then, and keeping all under a glass shade for perhaps a fortnight.

A knife shaped like a lancet, with the edges blunted, so as not to cut the specimens, was very useful for moving sections from one fluid to another.

Mounted needles are best fixed in a quill. There was nothing equal to it. A rigid handle for mounting needles was most objectionable.

Mr. Groves then proceeded to mount sections in glycerine and also in balsam in order to illustrate his remarks, and passed round the slides for the inspection of the members. He then went on to remark that in mounting from oil of cloves it was desirable to get rid of the oil as much as possible by draining it off before pouring on the balsam.

New Canada balsam was useless for mounting, while if dry it did not soak thoroughly into the specimens. The balsam should be placed in an oven until it was hard, and chipped easily, and then dissolved in benzole until about the consistency of molasses.

Briefly summarised the process was get the specimen as fresh as possible, harden it well, cut as thin as necessary, stain it carefully, dry it out of water with spirit, clear with oil of cloves, and mount in balsam.

With very large sections it was inconvenient to use the lifter. In such cases the cover glass could be used as a lifter. The cover glass being placed on the solid glass cap and the specimen arranged on it, the balsam could be poured on and the slip lowered on to the cover. Such a specimen could not be examined safely for two or three weeks.

All mounted specimens, especially those in fluid, should be kept flat, not on edge. If kept in racked boxes, the boxes should be stood on end. He strongly recommended that all slides should be labelled as soon as put up, as even if the structure could be recognized they would probably forget the animal it came from.

The following objects were exhibited :—

Transverse section of mesentery of Calf ...	Mr. W. I. Curties.
Foraminifera from Porto Seguro	Mr. H. E. Freeman.
Palpus of Spider	Mr. H. G. Glasspoole.
Supposed new Genus of Marine Worm ...	Mr. W. Goodwin.
Young Oysters, polarized	Mr. H. Morland.
Œdogonium showing oospores	Mr. J. W. Reed.
Section of Meteorite showing fused crust ...	Mr. G. Smith.

Mr. Groves also showed in illustration of his demonstration the following sections :—

Cornea of Frog.
Nerve fibres medullated.
Tactile hairs from lips of Cat.
Tongue of Dog.
Æsophagus and trachea.
Stomach of Dog, cardiac extremity.

Attendance—Members, 66 ; Visitors, 11.

December 22nd, 1882.—Ordinary Meeting.

Dr. M. C. Cooke, M.A., A.L.S., &c., President, in the Chair.

The minutes of the previous Meeting were read and confirmed.

Mr. E. Bucknall and Mr. J. B. Hilditch were balloted for and duly elected Members of the Club.

The following donations and additions to the Club Library and Cabinet were announced :—

"Journal of the Royal Microscopical Society"	From the Society.
"Journal of the Postal Microscopical Society"	" "
"Transactions of the Hertfordshire Natural History Society"	" "
"The Scientific Roll." Nos. 6, 7, and 8 ...	" the Publisher.
"The Analyst"	" "
"The Northern Microscopist"	In exchange.
"The American Monthly Microscopical Journal"	"
"Coles' Studies." Nos. 29 to 32	Purchased.
"Annals of Natural History"	"

The thanks of the Meeting were voted to the donors.

Mr. Scofield suggested that the donations and additions to the property of the Club acquired, say that evening, should remain upon the table during the next conversational evening. At present the books went at once into the

book case, where, of course, the members had access to them; yet he thought they might very well be laid on the table for an evening

The President said that no doubt Mr. Smith, the Librarian, would be glad to meet the wishes of the members as far as he could.

The Secretary observed there must be a stipulation that the books should not be removed from the table, specially set apart for the purpose, under any circumstances. As to the slides for the Cabinet, it might be arranged that Mr. Coles' slides should be left on the table for an evening, but as to other specimens he thought they should be left with the Curator.

Mr. Hailes read a communication from Dr. Whittell, written by him since his return to Australia, " On making cells from thin glass," and " Hints on mounting in glycerine."

After reading the paper, Mr. Hailes remarked that he had long used a similar method of forming thin glass cells, but that he used shellac instead of gum. He had a few metal plates with holes of suitable sizes made in them, and these plates he warmed one at a time, and fixed on the thin glass with shellac. After fixing on two or three, the first rings would be cold and the centre could be readily knocked out and the hole trimmed up with a half-round file, then by warming the ring and slipping off the cell he had very few failures. As to mounting in glycerine he had tried a plan he had seen mentioned in one of the Journals a little while ago, and which seemed to promise well. After wiping off as much of the surplus glycerine as could be easily removed he put a ring of gum mucilage round the cover. When this ring had set he dropped a little bichromate of potash upon the gum, and exposed it to the action of the light. In the course of an hour the gum would be converted into an insoluble resin, and the slide could be safely washed in water and finished off in the usual way. He had mounted some blood corpuscles of the whale in this way, and found it answered admirably, but of course he could not tell how it would stand the test of time. He thought the process worth trying, but it would require some years to really test its permanence.

The President remarked that any plan which required slides to be set on edge, for drawing or otherwise, was objectionable. Fluid mounts should be kept perfectly flat, or the object would be sure to move, especially when mounted in glycerine.

Mr. Groves said it was necessary to clear up the last trace of glycerine. The most convenient method was to moisten a sable or camel hair brush between the lips, and so wipe up the surplus glycerine. That answered better than bibulous paper. In cementing down the covers, especially square ones, it was a good plan to make a line or ring of cement on the slip a little way from the cover and a similar line on the cover, and then with a brush full of the cement bridge over the space between the two lines of cement.

Mr. Ingpen inquired if the bichromate of potash was likely to be acted upon by the glycerine. He feared that if the glycerine got at it, having such a solvent power on salts of that kind, it might be detrimental. He observed that the papers just read had some extra interest in the knowledge that Dr.

Whittell, who was in England for nearly two years, took a great interest in the Club and formed a number of friendships among the members. He had not forgotten them, and had not only sent them some communications, but had forwarded him a newspaper in which was mentioned how he had brought the subject of diffraction spectra before the Microscopical Society of Victoria to their great astonishment. It was quite a new idea to them. Dr. Whittell took great interest in the optical parts of the microscope.

Mr. W. Dalton Smith said those who had experienced difficulty in sealing glycerine mounts would find the plan he adopted useful. He made a preparation of five parts of asphalt, one of the newest Canada balsam, and one of gold size, by measure, with sufficient benzole or turpentine to make the mixture sufficiently thin for use. He then made a cell of the size required and left it until wanted. It would remain sticky for one or two months, so much so that the cover would adhere quite firmly with simple pressure, and all trace of glycerine could be washed off. The slide could then be rubbed dry without fear of injuring the object or moving the cover, and could be finished with Ward's brown cement or any preparation of that kind. He believed such slides would be found permanent.

Mr. T. C. White remarked that he had used coaguline, but found that it contracted so much that the cover glass was broken all to pieces.

Mr. Hailes said he used ordinary gum mucilage, which was entirely changed in character by using the bichromate of potash. The gum should not be allowed to dry, but merely to set, then by dropping a little bichromate on the cover, it acted rapidly upon the gum, which by exposure to the light became insoluble in water. The slide could then be washed off and finished.

Mr White observed that he did not know the effect of adding bichromate of potash to gum. He knew it acted in that way with gelatine. This was useful for making large trays water-tight, giving them a coat of glue and then treating with bichromate of potash.

The President suggested that perhaps gum tragacanth could be used. It would certainly be insoluble.

Mr. Hailes replied that he thought gum tragacanth would shrink too much to be used for that purpose.

Mr. T. C. White reminded the members of the suggestion he had made in a casual communication to the Club some time ago. A mixture of gold size and indiarubber dissolved in benzole, to which was added some of the shellac called French glue. It required to be put on thin and dried very quickly. When dry another ring could be run on, and the slide finished in the usual way. This cell gave sufficient elasticity to allow the glycerine to expand, and any kind of finish could be used.

The cordial thanks of the meeting were then given to Dr. Whittell for his communication.

The President, in announcing the arrangements for the ensuing month, specially referred to the satisfactory demonstration given at the last conversational meeting, and mentioned that the second of the series would be given on the 12th proximo "On Photomicrography," by Mr. T. C. White.

Mr White observed that in view of that demonstration he had brought with him some photographs, which he did not put forward as specimens of photography, but as a method of illustrating objects which were shown under the microscope, so as to be easily appreciated by observers. It was a trying experience with many to stand by their microscope and explain the different parts of the object to be observed. He had used these photographs with a few letters and figures as references, and was thus relieved of further trouble in explaining the object. He wished to show how members could do this for themselves, by using dry plates, during the dark winter evenings.

By permission of the President, Mr. A. W. Stokes invited the members to assist at the Inaugural Soirée to be given by the Association of Medical Students at the Holborn Town Hall at the end of January.

The proceedings terminated in the usual Conversazione, at which the following objects were exhibited :—

Selected Foraminifera from Florida ...	Mr. H. E. Freeman.
Podura Scale, and Amphipleura pellucida, with Messrs. Powell and Lealand's oil Immersion 1-12 objective N.A. 1·43 and vertical illuminator	Mr. E. M. Nelson.
Section of Leaf of *Hedychium Gardnerianum*, double stained	Mr. J. W. Reed.

Notes on Vaucheria.

By M. C. Cooke, M.A., A.L.S., &c., President.

(*Read January 26th*, 1883.)

The structure and development of *Vaucheria* has been so often, and so well studied and illustrated, that the observation of any new features is quite unexpected, and will probably encounter some opposition, or at least excite some doubt. One of the generally accepted conclusions is, that the threads of *Vaucheria* are continuous throughout their length, only presenting septa at the time of reproduction, when the short branchlets are isolated for that purpose. At all events, successive septation of the main filament does not appear to have been recognised by anyone who has written upon this family. Of its development, it is stated that "the lower part of the germ cell grows out into a branched pale-coloured root, and the upper part is elongated in a still more considerable degree into a stem-like filament, which grows on and on by apical development until its growth is finally arrested by fructification." That is, in effect, the recognition of *Vaucheria* as unicellular.

During the keen weather at the commencement of the present winter, Mr Frederic Bates, of Leicester, collected some filaments of *Vaucheria* from under the ice, and upon submitting them to the microscope discovered that the main threads were much divided by septa. He sent me portions of these threads mounted, and as there was no positive evidence of the filaments belonging to *Vaucheria*, at once I was prompted to reject his conclusion, and affirm that some filaments of *Cladophora* must have been mixed with the *Vaucheria*, for not only were the threads distinctly septate, but there was an accumulation of plasma in the cells, and an appearance as of differentiation. Subsequently, however, all doubts were removed, for I obtained a part of the gathering, and saw the oogonia and antheridia so characteristic of *Vaucheria*, seated on filaments which, at a short distance were septate in a similar

manner to the previously examined thread. The whole gathering showed a great preponderance of septate filaments, divided completely, and somewhat constricted at the joints, some of the cells being two and others three times, or more, the diameter in length. Filaments which did not bear Oogonia, or only one or two, being most divided. Approaching the subject with a strong feeling adverse to the production of veritable septa, every precaution was taken, I think, to prevent any misinterpretation, and I was compelled against my first impression to accept the fact that the filaments of this undoubted *Vaucheria* had become divided off into cells, at the period of fructification.

The appearance of these cells, in some sense differed from continuous threads, in that the plasma was collected towards one end, or the centre of the cells, and in many instances was dense, apparently mingled with oval bodies as if undergoing, or had undergone, differentiation. It must be stated that the filaments were very much coated with small *Diatomaceæ* and other minute Algæ, so that the view was obstructed.

The question which at once suggested itself was, as to the object of this septation. And here it may be suggested that the single asexual zoospore, produced in small numbers, and the single oospore produced in the oogonia always had appeared to be a very sparse provision for the reproduction of the species, as compared with the large number of zoogonidia, which are produced in every fertile cell of *Cladophora* and *Chætomorpha*. Even in the *Botrydiaceæ*, the multiplex modes of reproduction are strongly in contrast with what has been known as the reproductive process in *Vaucheria*. For these reasons there does not appear to be any improbability in the supposition that zoogonidia may be produced in *Vaucheria* in cells, divided off for that purpose. The formation of the cells, the accumulation of the cytioplasm, acquiring density, and as I strongly believe, differentiation lend strength to the probability that reproduction by zoogonidia may yet be discovered in *Vaucheria*. We failed, both Mr. Bates and myself, to detect any active zoogonidia, but we have both seen bodies of a definite form, resembling zoogonidia at rest, in the cells, and in the water in which the gathering was kept were found similar bodies outside the threads, some in a state of germination. It must not be supposed that we affirm, or have direct evidence to affirm either that zoogonidia *are* produced in the cells, or that the free germinating

bodies are escaped zoogonidia, but these circumstances are mentioned as showing how necessary it is that *Vaucheria* should again become the subject of investigation, for the purpose of discovering, beyond doubt, what is the cause and true interpretation of this unsuspected septation of the filament.

On a Newly Discovered British Sponge.

By J. G. Waller.

(*Read February* 23, 1883.)

PLATE VIII.

I have the pleasure of bringing before you another sponge, which I believe to be new to the British fauna, making the third I have discovered within a very small range of coast. And I think I shall also have one more for a future occasion, found within the same limits, viz., from the eastern promontory of Torbay to its central shore at Paignton. Now, considering that my opportunities, when staying at Torquay, professionally engaged, have been restricted to very brief visits to the shore, it justifies what has been expressed by Dr. Bowerbank, and again by his editor, the Rev. A. M. Norman ("Brit. Spongiadæ," Vol. iv., p. 4) how much more our coasts may yield to this department. Dr. Bowerbank says, alluding to the increasing number of species, "It is strikingly apparent, from the many new species continually being found among the sponges dredged and otherwise collected by British naturalists, that those already described do not by any means comprise the whole of our British fauna ; and it is highly probable that future labourers in this interesting field of natural history will add very considerably to their number." Mr. Norman, in alluding to a table compiled by him, showing geographical distribution says (p. 4) :—"The table makes it clear that the sponge fauna of many parts of our seas remains almost wholly unexplored ; and it is hoped that the very deficiency exhibited here will have a tendency, among other causes, to induce our younger and rising naturalists to take up the great field of research which here lies open to them. Speaking from a very extended knowledge of the zoology of our coasts, I unhesitatingly state that no other class of animals offers to the student so rich a field for exploration, or one in which he is likely to meet with so many hitherto unknown species."

My own small experience testifies in the same direction. None of the species described by me are found in Dr. Bowerbank's Vol. iv. lately issued. Yet it may be of use, if I state that my modes

of exploration were by no means elaborate. I simply used such opportunities as were afforded me, out of the very spare time at my command, and kept my eyes well employed. Only one did I find alive and *in situ*, and that was obtained in a single visit to Paignton rocks at dead low water, spring tides. To those who would study these organisms, I would recommend my own practice of picking up the roots of Laminaria, which are great gatherers of sponges; and many interesting species I have obtained in this manner, besides one entirely new to our fauna, which I have described.* Those therefore, who would commence the study need not frighten themselves at a necessity for dredging; they would find plenty to occupy them on what are cast upon the shore after rough weather, and examining rocks at low water with a sharp exercise of their visual faculties. So numerous a society as ours could most surely help beneficially in the study to a greater extent than is now done; I am quite sure of this, that whoever has courage to begin will most surely go on. Our friend and colleague, Mr. Priest, is a proof of this, and will quite bear out my opinion.

The sponge, I am about to describe, was found on an oyster shell cast up on the shore, filled with *Cliona Northumbrica*, at Hope's Nose, that wild promontory which terminates the eastern side of Torbay. It is an ancient landslip, which has surged forward to the sea, and one of our last winters witnessed a slight extension of the process, carrying with it an interesting example of contorted strata. Here the sewerage of Torquay now pours forth into the sea, and the olfactory nerves of a visitor are not always agreeably affected. But it is rather amusing to note the crowd of seagulls floating close about the out-flow; whether enjoying it or whether sitting in sanitary congress, we have no means to determine. All my late visits I had to myself, and I do not think it is now thought quite a place for a boating party to picnic at. To be there at the decline of day, with a rising wind and overcast sky, and occasionally a half-human cry from the sea-birds, gives to the position a lonely dreariness, which only the pursuit of natural history could make you quite ignore. But it affords such an abundant means of study, in its rock pools, crevices, &c., of all kinds of marine life, that hours may quickly pass away in profit. I generally returned with a miscellaneous assemblage of pebbles, shells, &c., &c., in my pockets, and one result is the new sponge.

* "Journal of Quekett Microscopical Club," Vol. vi., p. 97, *et seq.*

Without the microscope it would not have been discovered ; for it was by passing it over the shell, examining numerous incrustations, that I noticed a small patch of bihamate spicules. The patch was not bigger than an eighth of an inch, but so difficult to detach from the shell's rough surface, that a large part was destroyed in the process ; it belongs to the lowest form of the filmy sponges. The tiny object therefore, which I secured and mounted, is rather under 1-20th of an inch in diameter ; but it would exceed this if it could all be flattened out, by treble that size. As it is, however, fortunately it exhibits all the characteristics of the sponge, which is one of the most interesting of its kind it has been my fortune to see, and introduces us to a form of spicule not hitherto found, as far as my present knowledge goes, in the Spongidæ. This alone would make us rejoice in the discovery, though it is not the only point of interest.

My specimen partially coats a fragment of oyster-shell, as also portions of a structureless substance, like the glutinous lining of the tubes of annelids, and seems to belong to Dr. Bowerbank's genus *Hymeraphia*. The simplicity of structure which marks this class is shown by its consisting of a membrane, strengthened with spicules. In this example the membrane is very translucent, and scarcely visible when mounted in balsam. Upon this is a skeleton made of clavate cylindro-arcuate spicules, somewhat long and disposed in fasciculi (Fig. 1), these being loosely connected by a few single spicules of the same kind. They measure 30-4000ths of an inch. (Fig. 2.) But one of the most distinctive features is, that the membrane is bound together by a close interlacing of contort bihamate spicules, very numerous, and making a confused network. The normal size of these is 7-4000ths of an inch. Intermingled with these are others of the same form and character; but nearly three times the size, very few in number, whose purpose might fairly be supposed to clamp and strengthen this network. (Figs. 3, 4, 5.) There are also anchorate spicules along with this reticulated mass. Some large, tridentate, and bidentate of same kind ; equi-anchorate, few in number ; others very small, more abundant ; often very difficult to detect in the confusion of the bihamate network ; and some very minute, which may more possibly be considered to be in an undeveloped state. The large forms are remarkable in the unequal character of the flukes. In the bidentate one flange is smaller than the other ; the tridentate has a fine projection from one central tooth, and the other fluke has a

kind of duplicate flange, only to be expressed in the given figure. (Figs. 6, 7, 8, 9.) There are also a few arcuate entirely spined forms of spicules, projecting through the membrane ; the spines are minute, but more developed at the base : these are very sparsely distributed. (Fig. 10.) Lastly comes the curious and novel shape, also in the reticulation of the membrane, and intermingled with it. It is in the form of forceps, as sugar-tongs, or more nearly a lady's hair-pin. The shafts are cylindrical and equal throughout, incipiently spinous, but very slightly defined, giving a somewhat uneven look to the whole, and they are rounded at the terminations, where in some specimens they slightly diverge from the straight line. At what may be called the *spring* of the forceps is a bulbous heart-shaped development, but this is only found on one side. (Figs. 11, 12.) This form averages in length about 6-4000ths of an inch. It is sparsely distributed, but is more numerous than the large bihamate or the spinous arcuate spicule, and some embryonic forms are here and there to be seen developing on the membranes. (Fig. 13 *a*.) None such has before been discovered in the sponges, but an instance of a forcepiform shape is figured by Dr. Bowerbank (Vol. iii., Pl. XLIII.), as belonging to his species *Halichondria forceps*. In this, however, the shafts are long and unequal, and it is entirely spined.

Exotic sponges give us some varieties of the forcepiform spicule. In the "Annals and Magazine of Natural History," 4th Series, Vol. xiv., Mr. Carter figures and describes two examples. One is from a sponge found in the dredgings of the "Porcupine," from the Atlantic Ocean ; another from an arenaceous dredging near Colon or Aspinwall, Panama. The first is from a sponge named *Esperia cupressiformis*, and the forcepiform spicule is described (p. 248) as very minute, and having bulbous inflations at the extremity of each arm (fig. 15). The second was obtained by Mr. F. Kitton from the dredging above-named, and Mr. Carter names the sponge from which it issued, though unknown, *Forcepia colonensis* (Fig. 16).

The figures given in Pl. VIII. are copies from those in the "Annals." There is also another form I have met with in a curious sponge, which constructs its network of an indiscriminate mixture of extraneous spicules, either whole or fragmentary. I am ignorant of the sponge from whence it came, but it is given in Fig. 15. Mr. Carter also gives the forcepiform spicule of *H. forceps* (Bowerbank) ; and he alludes to having found a minute

sponge on the "rocks" at Budleigh Salterton, which contains a spicule similar to that of *Esperia cupressiformis*, but without the bulbous ends, hair-pin-like. "It is *very* minute, not being more than 2-6000ths inch long, but in company with the same kind of equi-anchorate and double form of skeleton spicule as those in *Halichondria forcepis*, though not the same species." (Fig. 17.) From this it would appear that the sponge at Budleigh Salterton is distinct from that found by Hope's Nose, Torquay, now under consideration, and this is a subject of interest, as showing that the forceps form of spicule is very much varied in size and shape.

By the kindness of Mr. Carter I have had an opportunity of examining a piece of sponge from Port Elliot in Australia, in which is a similar form of spicule, but of small size ; it is given at Fig. 18. Also in Vol. i., Pl. VII., of the "British Spongiadæ" is figured a small spicule from an Australian sponge, with some approaches to the forcepiform shape. It is called by Dr. Bowerbank subspinulato-arcuate, and is more like a stilted arch than a forceps, still it must be associated with that form. (Fig. 19.) Fig. 20 is another example from an unknown exotic sponge found amongst an indiscriminate medley of various spicules, fragmentary, and otherwise, in a sponge that thus makes up its skeleton. It is entirely spined, and has conical bulbous terminations to the arms.

It is strange, to me at least, that such a distinct shape as the forceps should be classed under the generic term of *tricurvate.* But so it appears to be by Schmidt as stated by Mr. Carter. That a term geometrically precise, implying curves formed from three centres can be properly applied to a form which has only one, is to my mind a perversion, having a tendency to confuse our terminology already full of difficulties. The slight tendency to flexure shown in the arms of that of *H. forceps*, and the *indentation* in the form of that of *Forcepia colonensis*, certainly do not warrant it, for neither show anything that can reasonably be termed a curve, except the principal, which I call the spring of the forceps. None of the examples I have seen have any pretensions to be called "tricurvate," whilst most of them could not be so classed without an abuse of the term. That of the sponge I have described is almost of the shape and proportions of a tuning-fork, and to seek a triple curve in that would be hopeless. The tricurvate spicule found in so many sponges is very definite, and truly so-called.

The forcepiform is equally so, and they should not be classed together. I do not think there can be anything gained by it, and though one must feel respect for the opinion of such an eminent worker in this department as Schmidt, it is a question of so simple a character that all observers stand on the same ground.

We have now to consider the analogies, which are not many, and do not belong to the genus. First amongst them is *Raphiodesma sordida,* a coating sponge also, but of a higher or more complex type. In the dermal membrane of this sponge we get a great number of bihamate spicules, also numerous anchorate ones, and the skeleton spicule has resemblances in its arcuate and clavate character. But the anchorate spicules differ in shape, and many other important divergencies are to be found. I have before alluded to the association of forms of spicules together as bearing on the affinities of one class of sponges with another. But I do not believe that any good classification of sponges will ever be generally accepted if based on the forms of spicules only. They are very important adjuncts, but of themselves are certainly not sufficient.

The nearly allied genus *Hymedesmia* furnishes an analogy in the numerous complication of the bihamate spicules associated with anchorate forms, in the species *H. Zetlandica,* and the fasciculated arrangement of skeleton spicules, there seen, bear some resemblance. *Hymeniacidon variantia* is also remarkable in this particular.

In some exotic sponges also the membranes have often an abundance of bihamate spicules, which form usually occurs indeed in numbers, and rarely otherwise. But in this instance they are exceptionally numerous, and evidently play an important part in the structure.

In examining a filmy sponge, one must be very careful to assure ourselves that it is fully developed, and not merely a beginning, or you may very easily be mistaken, and call that a new species, which indeed is but a known form in an early state. Some of the early conditions of *Halichondria incrustans* might easily seem to belong to Dr. Bowerbank's genus *Hymedesmia,* but a careful examination of the spicules in this, as in other cases, may be sufficient to warn you from falling into error.

Before leaving the subject, I think I must call attention, for the second time, to an erroneous conception of Dr. Bowerbank, if not

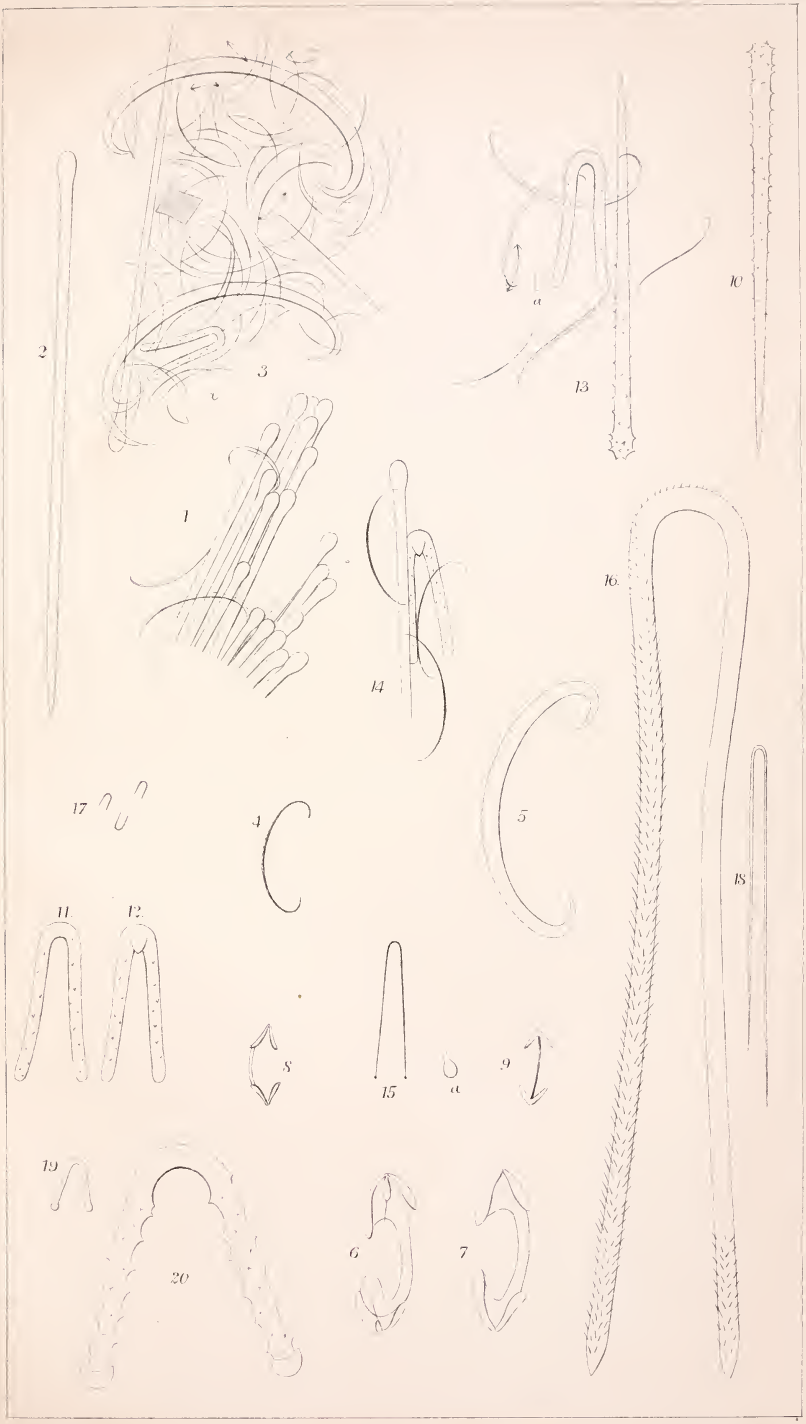
also of others, in making two forms of bihamate spicule out of what is certainly but *one*. The contort bihamate and the reversed bihamate (*vide* " Brit. Spongiadæ," Vol. iii., Pl. LXII., 5, 6, 12, 13) are not different forms at all, but only the same in different positions. By bending a piece of wire to the shape you can easily show it produces also the other appearance by mere change of position. In this sponge you see it in every possible view, and it completely demonstrates what I have stated. This is one of the cases amongst many in which vision by the microscope should be guided by reasoning, and not be depended upon for a final result in determining forms without its continuous exercise.

It is always satisfactory when we can add a new object to our fauna, and thus extend our knowledge of the class to which it belongs. Still more is it interesting when the new form has some remarkable speciality, as seen in this sponge. I am happy therefore to place a record of it before our Society, regretting much, that at present, the knowledge of it should be confined to the one small speck which I have been enabled to conserve. In the dry state in which I found it the colour appeared to be dark brown, but I am not certain if this might not have been due to the colour of an extraneous substance upon which it had developed. I propose to call it *Hymeraphia forceps*, classing it under Dr. Bowerbank's system.

Hymeraphia Forceps. J. G. Waller.

Sponge coating, consisting of a simple membrane strengthened by spicules. Skeleton composed of a fascicular arrangement of spicules lying horizontally, connected by a few single ones, but without any definite order. Spicules clavate, cylindro-arcuate, rather long, the membrane thickly interlaced with bihamate spicules, with a few larger ones, as it were, clamping them together, three times their size. Intermingled with these are a few equi-anchorate, bidentate, and tridentate spicules, the larger ones abnormal in the flukes and in the flanges, the smaller more numerous and more equal ; also a forcepiform spicule having the arms equal, rather stout, terminations rounded, incipiently spined throughout, and somewhat uneven. They diverge slightly at base : at the arch, on one side only, is a heart-shaped bulbous inflation. Also a few arcuate, entirely spined spicules, which project outwards as if for defence, very sparsely distributed. Spines more numerous and pronounced at the base.

Habitat.—Hope's Nose, Torquay. Parasitic. Examined in the dry state. Colour unknown in the living condition.



J G Waller, del[t]

Mintern Bros imp

DESCRIPTION OF PLATE VIII.

A drawing of the sponge itself, as preserved, would scarcely convey its special characters, as it is partially obscured by extraneous matters, fragment of shell, &c. The following details will, however, illustrate the structure :—

Fig. 1.—Fasciculi of skeleton spicules ; terminations concealed.

Fig. 2.—Skeleton spicule. Size, 30-4000ths of an inch.

Fig. 3.—Portion of membrane showing the intricate interlacing of bihamate spicules and a forcepiform spicule at base (*a*).

Fig. 4.—Small contort bihamate spicule. Size, 7-4000ths of an inch.

Fig. 5.—Large „ „ „ „ 17-4000ths „

Fig. 6.—Large tridentate equi-anchorate spicule showing a remarkable development at base like an expansion of additional fluke. A minute spine also seems to project from the central tooth of the upper fluke. Size, 5-4000ths of an inch.

Fig. 7.—Large bidentate equi-anchorate spicule. Flanges of flukes of unequal length. Size, 5-4000ths of an inch.

Figs. 8, 9.—Two views of small bidentate equi-anchorate spicule. Size, 3-4000ths of an inch.

Fig. 10.—Arcuate, entirely spined spicule. Size, 20-4000ths of an inch.

Figs. 11, 12.—Forcepiform spicule showing two sides, one having a bulbous inflation at the arch, incipiently spined. Size, 6-4000ths of an inch.

Fig. 13.—Group of spicules. Entirely spined arcuate spicule; forceps formed at base of its arm (*a*), another developing on membrane, &c., &c.

Fig. 14.—Another group with skeleton spicule and reverse of the forceps form. Figs. 1, 2, 10, 13, 14 drawn to same scale.

Fig. 15.—Forcepiform spicule from *Esperia cupressiformis*, copied from plate in Vol. xiv. of "Annals of Natural History, &c.," 4th series. (*a*) Bulbous termination of arms largely magnified.

Fig. 16.—Ditto from *Forcepia colonensis*, copied from figure in above. Spines omitted on one arm. Mr. Carter remarks that this is really not half so long as that of Fig. 15. Its scale is 1-12th to 1-6000ths of an inch.

Fig. 17.—Minute forcepiform spicule from sponge found by Mr. Carter on the rocks at Budleigh Salterton, drawn by him from memory. (See "Annals, &c.," as above quoted).

Fig. 18.—Forcepiform spicule from a sponge from Port Elliot, Australia. It resembles that given by Dr. Bowerbank ("British Spongiadæ," Vol. iii., Pl. XLIII.) from *Halichondria forceps*. Size, 5–2000ths of an inch.

Fig. 19.—Small forcepiform spicule, given by Dr. Bowerbank, from a sponge from Western Australia, but called by him "sub-spinulate arcuate." (See "British Spongiadæ," Vol. i., Plate VII., Fig. 173.)

Fig. 20.—Entirely spined forcepiform spicule, with bulbous inflations at ends of arms, from an unknown exotic sponge, allied to Dysidea by taking up extraneous particles of various spicules of other sponges.—N.B. The magnifying power is different in several figures which are not to the same scale.

On an Easy Method of Preparing Insects for the Microscope.

By Staniforth Green.

(*Read April 27th*, 1883.)

My experience in mounting insects for the microscope extends as far back as the year 1861. For the first five or six years I was content to follow the then prevalent method of soaking the insect in liquid potash, which dissolved its muscular structure and left nothing but its empty skin. In that condition it was easy enough to arrange legs, wings, &c., in proper position, but the result was not satisfactory, as the shape and beauty of the insect was entirely lost by the pressure employed in squeezing out the decomposed tissues. This became more apparent to me on my becoming possessed of a binocular microscope, and I at once took to mounting insects without pressure. I found no difficulty in making them sufficiently transparent without the aid of liquid potash, but was sorely troubled in endeavouring to arrange them in proper position. Legs would double up and wings would not remain expanded. It is only very recently that I have overcome the difficulty, and as this new method of mine may also be novel to other amateur mounters, I will endeavour to describe the treatment as clearly as possible.

On capturing an insect, consign it at once to the poison bottle if convenient, and there let it remain until it is quite dead. Do not let it lie in the bottle for longer than half an hour. Ten minutes is generally sufficient. The action of the cyanide of potash would in a few hours injure materially the muscular structure of the insect, and spoil it as a microscopical object. You should remove the insect before its legs and wings have become rigid ; but first have ready a small piece of glass, on the surface of which spread a thin film of rather stiff Canada balsam. Then place the fly, or any other insect you may be operating on, lightly upon the Canada balsam film in the position you desire. If a dorsal view is required, and a winged insect the subject, place it back upwards,

then with a fine needle or pin arrange its legs and wings. The legs may be made to adhere their entire length to the balsam, but it is desirable that only the tips of the wings be held down by the balsam. In this position the insect should remain for two or three hours to allow the balsam to become harder and the limbs of the insect stiffer. Then place the piece of glass with the insect adhering to it in spirits of wine, where it should be allowed to remain for two or three days. It is not unlikely that in the course of a few hours the action of the spirits may cause the film of balsam to become detached from the glass. This will not matter, for the hardened film will be found sufficiently dense and strong to keep the legs and wings of the insect in the position they were originally placed by the setting needle. Should, however, the film not become detached when it is time to withdraw the piece of glass from the spirits, it is easy to remove the insect by placing the piece of glass in spirits of turpentine, which will dissolve the hardened balsam. If, as mentioned before, the film has become detached from the glass a few hours after its first immersion in the spirits, it should remain undisturbed in the spirits for some days, and then it can be treated with turpentine. It should be kept in clear spirits of turpentine until it has become sufficiently transparent for mounting in Canada balsam. I have been very successful with spiders, but there are some species that will crumple up their legs unless pinned out. The pinning out is not at all a difficult process ; it merely takes a little more time. Fasten with fine tin wire a thin cutting of cork to a piece of glass, then spread a thin film of Canada balsam on the cork. Lay the spider in position on the balsam, and having previously cut the points of a number of fine pins, take the points up with a pair of light forceps and stick them into the cork against the inner side of the legs of the spider. One point, if properly placed, will be sufficient for each leg, as I have nearly always found. The palpi and mandibles may be also kept in proper position in the same way. After this has been accomplished put the whole in spirits of wine and follow out the treatment described for flies. The piece of glass must, of course, be sufficiently heavy to sink the cork in the spirits. Care should be taken in withdrawing the pin points when the spider is ready for transfer to spirits of turpentine. The hardened balsam must first be dissolved, then the pin points taken out and the spider carefully removed from the cork. When quite clean place it on another piece of cork or glass, and

pin out as before and put it into the turpentine bath, where it should remain until it is fit for mounting in balsam. I keep two or three dozen pin points stuck in a piece of cork ready for immediate use. They should be about one quarter of an inch long and tolerably fine. In setting ants on the film of Canada balsam I find their jaws will not always remain open. To prevent their closing I sometimes place a small splinter of wood between the points of them, which, if carefully done, keeps them well open. This precaution is not necessary while they are in the turpentine bath.

I have lately returned from a seven weeks' tour up country, and during that time I visited five localities, spending a few days at each place. I carried with me all that was necessary to prepare insects for mounting, so far as the spirits-of-wine process was concerned. I collected all interesting insects that I came across while hunting for objects, and I brought them back to Columbo in little bottles of spirits of wine, with the hardened balsam adhering to them. I have since examined them and they appear to have received no damage at all by the shaking they underwent, while my box was being carried about from place to place, over a rough and broken country. I have also mounted a few of them with perfect success.

If it is desirable to keep insects for any length of time before mounting them in Canada balsam, or if they have to be sent to a distance by post, the preparation of them should be stopped after they have been in spirits of wine on the film of Canada balsam. The film, with the insect on it, can be detached from the piece of glass by cutting the former with the point of a fine needle drawn round the insect. Remove the detached piece of film and place it in a small glass bottle full of clean spirits of wine. The hardened balsam can at any time be dissolved away from the insect by spirits of turpentine. I find that it is sometimes easier to set small insects in position by placing them on their backs upon the film of balsam. Their legs can be arranged in that position with greater facility.

One of the advantages of the poison bottle is that it kills insects apparently without much inconvenience to themselves. They seem to go to sleep in the cyanide of potassium.

Q. M. C. EXCURSIONS.

List of the Principal Objects Obtained.

Communicated by Dr. M. C. Cooke *and* Mr. W. G. Cocks.

(*Read April 27th*, 1883.)

Regent's Canal and Botanic Gardens, April 7th, 1883.

Scenedesmus quadricauda, Breb.
Stigeoclonium protensum, Dillw.
Spirogyra nitida, Link.
Conferva bombycina, Ag.
Drilosiphon muscicola, Kutz.
Oscillaria tenuis, Ag.
Oscillaria Frolichii, Kutz
Cosmarium margaritiferum, Turp.
Closterium moniliferum, Ehrb.
Vaucheria sessilis (Vauch.)
Œdogonium, sp.
Spirogyra, several species, sterile.
Cladophora fracta, Kutz.

Daphnia Schœfferi, an uncommon and beautiful form, remarkable for its long, serrated tail.

Daphnella wingii, a rare form with very large arms or swimmers, and having a singular habit of lying them flat against the body and simulating death.

Brachionus, sp., in immense numbers, and very fine.
Euchlanis triquetra.
Stentor mulleri, in great numbers.
Œcistes crystallinus.
Melicerta ringens.
Rotifers, various.
Stellate hairs from stem of *Aralia papyfera.*

Caen Wood, Highgate, April 21st, 1883.

Mesocarpus pleurocarpus, D. By.
Spirogyra nitida, Link. }
Spirogyra Weberi, Kutz. } All in fruit.
Spirogyra calospora, Cleve. }
Hydrianum polymorphum, Reinsch.
Gonium pectorale, Müll.
Closterium moniliferum, Ehrb.
Scenedesmus acutus, Meyen.
Licmophora splendida, the beautiful fan Diatom; rarely met with.
Dinobryon sertularia.
Difflugia proteiformis, very large.
Newt's eggs.
Floscularia.
Melicerta ringens.
Epistylis anastatica.
Œcistes crystallinus.
Vaginicola crystallina.
Actinophrys sol.

DIATOMACEÆ.

Encyonema paradoxum.
Cocconema lanceolatum.
Gomphonema acuminatum.
Diatoma vulgare.
Synedra splendens.

PROCEEDINGS.

January 12th, 1883.—Conversational Meeting.

A demonstration on "Photomicrography" was given by Mr. T. Charters White, F.L.S., F.R.M.S., in one of the class rooms, to a large gathering of members.

As the various processes had necessarily to be carried out in a darkened room, Mr. White, before entering on the *modus operandi*, explained shortly the simple apparatus he had devised and used with some success, for obtaining enlarged photographs of microscopic objects, which, though not fine examples of photography, were useful to illustrate and explain objects exhibited under the microscope. Such a photograph placed by his microscope with a few descriptive remarks and reference letters on the photograph, enabled him to direct attention to any points of interest in the specimens exhibited, and it was not necessary to stand by the microscope a whole evening to explain the object he was showing.

The method most generally practised and recommended was that the microscope being placed in a horizontal position, its tube should be attached by a blackened tube or cone to the front of a photographic camera, the lens of which had been removed. Then these difficulties arose. It was not everyone who had a camera, and they might not feel disposed to go to the expense of procuring one, while all the members of the Club possessed microscopical objectives ; but, further, if they had a camera, it was not an easy matter to see the fine details of a subject through the ordinary ground focussing glass. Again, unless the camera and microscope were securely fastened down to a base-board, there was a tendency to unsteadiness, which was irritating in the extreme ; and further, the usual plan did not offer any advantages over that he wished to introduce to the notice of the members.

In the apparatus on the table, and which had been found so convenient, it was not necessary to have either a camera or a microscope, and it was so simple that it could be adopted by the youngest member of the Club ; but even with that, difficulties would arise which were altogether apart from the apparatus. For instance, objects differed in their capability of transmitting the actinic rays ; they might be too opaque or brown, or they might be stained blue or red. All these conditions varied the time of exposure, only experience teaching the requisite time to imprint the image on the sensitive film just sufficiently without under or over exposure ; that must be left to the cultivated judgment of the operator. Great assistance would be derived by the beginner keeping to one objective until he could produce a good result on every occasion, when a fresh one might be tried, the time of exposure being greatly varied by the magnifying power employed, the lower powers admitting of a shorter exposure, as more light passed through them.

The principles upon which this beautiful art was founded might be read in any of the many manuals on photography, and which were published at a cheap rate; therefore, leaving those, he would pass on to the practice. If anyone needed to learn about the various apparatus employed for photomicrography, full particulars would be found in Beale's "How to Work with the Microscope," and in Cutters' "Microscopical Technology," both of which works were in the Club library.

In the first place he claimed for his plan great simplicity, being, as could be seen, nothing more than a lidless box placed on its side. At the left end it had a square hole, but any aperture would do. A brass plate, having an adapter in it, slid in and out on runners for more easily changing the powers when it was desired to do so. Another aperture was made at the top, and covered by a blackened chimney to carry off the heat from the duplex paraffin lamp inside. Another aperture at the bottom of the right side served to admit the air to the lamp when the front of the box was covered up by the black focussing cloth; within the box, and attached to the left side, was a carrier working on a long and fine screw, which served to adjust the object to the correct focus. Two condensing lenses, one to render the rays of the lamp parallel, and the other to condense them on the object, completed the arrangement as far as the box was concerned. The light passing from these through the objective emerged as a cone, and on the principle of a magic lantern projected the image on a screen to the left of the operator.

The screen consisted of a heavy piece of wood, having a groove formed in it, and carrying another block upon which the screen was held. The screen which received the image might be made of an oblong piece of glass, either four and a-quarter inches by three and a-quarter inches, called by photographers a quarter plate, or by a plate 5 × 4, according to the amplification it was desired to employ, or as the nature of the object might indicate, or, if lantern slides were desired, on a square three and a quarter inches. These should have a piece of smooth writing paper gummed on that surface presented to the image. The image being then thrown on to the screen, and the hand placed under the focussing cloth, the carrier must be moved by means of the screw adjustment until the image of the object was sharply defined on the screen.

In many writings on the subject it was stated that the actinic and visual foci of microscopical objectives were not coincident. All he could say was that with the one-third of an inch, which he was about to employ, and with Zeiss's D, no alteration was needed from the visual focus. The screen might then be removed and its place occupied by a dry gelatine plate, and the exposure accurately timed according to the nature of the object; but only experiments could determine that. Care must be taken before making the exposure that the light through the objective was cut off till the plate was in position, when it might be allowed to fall on the plate for the requisite time, and then cut off again before removing the plate to the developing dish, this was obviously necessary to avoid blurring the image. It was needless to say that the only outside light must be a non-actinic red light, and no ray of white light must be allowed to reach the plate or it would be "fogged" —that was to say, when it was developed it would be veiled by a misty de-

posit in the film, therefore no actinic light was admissible until the plate was fixed.

The developer was the ferrous oxalate, made by a saturated solution of protosulphate of iron being added to a saturated solution of neutral oxalate of potash, in the proportion of one part of the iron to three parts of the oxalate; these were best when freshly mixed. If the plate had been rightly exposed the image began to make its appearance in about forty seconds, and grew under the action of the developer until it was full of detail. When the image showed faintly through the film on looking at the back of the plate, the development should be stopped, and the plate washed by a good rinsing in rain or distilled water. It was then placed in the fixing bath, which consisted of a solution of four ounces of hyposulphite of soda dissolved in a pint of water, that extracted all the silver which had not been acted upon by the light. The plate must then be thoroughly washed to rid it of the hyposulphite of soda; this was done by placing it in running water under a tap for half an hour. If the film contained a trace of hyposulphite it caused the image to fade out after a time.

Some plates had a tendency to frill, that was to say, the edges of the gelatine film, while wet, had a tendency to separate from the glass and to curl up. To prevent this the plate might be soaked for about five minutes in a saturated solution of alum, and then again well washed and stood up on a sheet of blotting paper to dry spontaneously.

Mr. White remarked that he had given these practical details before commencing the demonstration, to enable the members present to follow the practical part with a clear understanding of what he was doing, and why he did it, and at the same time the box and its contents had been getting warm, a not unimportant item in the proceedings, for if operations were begun before that took place, the glasses would become dewed with the moisture condensed on them, the brass would be in a state of expansion from the heat, the image would be wanting in definition, and the plate assuredly spoiled.

The room having been darkened, Mr. White proceeded to carry out the various processes he had described, the object photographed being a blow-fly's tongue. He then printed a positive picture of the same object on paper by the light of an ordinary paraffin lamp.

The demonstration was followed by a discussion, and the apparatus was afterwards exhibited in the Library, and further explanations given on various points.

The President moved a vote of thanks to Mr. White, which was carried unanimously.

The following objects were exhibited in the Library:—

Outer and Inner Epidermal Layer of Apple ...	Mr. F. W. Andrew.
Marine Alga. *Callithamnion byssoideum*, in fruit	Mr. T. H. Buffham.
Branched Hairs, Flower of *Anigozanthus flavidus*	Mr. E. Bucknall.
Tingis hystricellus, from Ceylon	Mr. F. Enock.
Sections of various Echinus spines	Mr. H. Hensoldt.
Diatoms. *Stictodiscus Buryanus*	Mr. H. Morland.

Stephanoceros Eichhornii	Mr. J. G. Tasker.
Paramæcium aurelia, treated with tannic acid to develop the cilia	Mr. H. J. Waddington.
Dallas-tints and Drawings	Mr. D. C. Dallas.

Attendance—Members, 81 ; Visitors, 27.

January 26th, 1883.—Ordinary Meeting.

Dr M. C. Cooke, M.A., A.L.S., &c., President, in the Chair.

The minutes of the preceding meeting were read and confirmed.

Mr. Charles Rousselet was balloted for and duly elected a member of the Club.

The following donations were announced :—

"Proceedings of the Royal Society"	From the Society.	
"Proceedings of the Geologists Association"...	,,	,,
"Proceedings of the Belgian Microscopical Society"	,,	,,
"Science Gossip"	,,	Publishers.
"The Analyst"	,,	Editor.
"Journal of the American Society of Microscopists"	,,	Society.
"The American Naturalist"	In Exchange.	
"The American Monthly Microscopical Journal"	,,	
"Journal of the Royal Society of New South Wales"	From the Society.	
"Annual Report of the Department of Mines of New South Wales"	,,	N.S.W. Govt.
"New South Wales in 1881"	,,	Royal Society of N.S.W.
"The Frog," by Dr. Marshall	From Mr. J. W. Groves.	
"Grevillea"	Purchased.	
"Annals of Natural History"	,,	
"Micrographic Dictionary." Parts 18 and 19	,,	
Cole's "Studies in Microscopical Science," Nos. 33 to 37	,,	
Nobert's 19 Band Test Plate	from Mr. Nelson.	
Three Slides of Shell Sections	,, Mr. H. Hensoldt.	

The thanks of the meeting were voted to the donors ; and upon the motion of the Secretary a special vote of thanks was passed to Mr. Nelson for his valuable donation.

The President announced that as the Excursion Committee for the ensuing season had been appointed, and were about to make their arrangements, they would be glad to receive any suggestions as to fresh localities to be visited which might be practicable and within a working distance.

The President regretted that they had been disappointed as to a paper

by Mr. J. G. Waller which had been announced for that evening, but which, owing to a severe cold, that gentleman was obliged to postpone reading.

Mr. A. D. Michael described, by means of black board diagrams, an organ situated on the tarsus of the front leg of certain of the Oribatidæ, which it appeared most probable was an auditory organ. He also communicated some particulars respecting the *Argassidæ*, which were so troublesome to strangers visiting parts of Persia.

A member inquired if these were the insects which attacked Mr. O'Donovan when in Persia? It appeared to him that, as the specimens described by Mr. Michael had fasted for three years, possibly their venomous properties might have been impaired. Climate also made a great difference in this respect, for it was well known that the Mosquito was by no means the same thing in an English forest and in an Indian one.

Mr. Michael said it did not follow that because a creature was innocuous in itself, that therefore it might be so after sucking the juices of a poisonous plant.

The thanks of the meeting were voted to Mr. Michael for his communication.

The President described and figured on the board a new form of fructification in the well-known fresh water Alga *Vaucheria sessilis*.

The Secretary announced that a Soirée of the Medical Union Society would take place on January 31st, and invited the assistance of members of the Club on that occasion.

The proceedings terminated with the usual Conversazione, when the following objects were exhibited :—

Section of Serpentine	by Mr. F. W. Andrew.
Granular Copper	„ Mr. A. L. Corbett.
Larva of Fly, *Stratiomid*	„ Mr. H. E. Freeman.
Haller's hearing organ in first leg of Ixodes ...	„ Mr. A. D. Michael.
Diatoms *Stictodiscus californicus*	„ Mr. T. S. Morten.
Eggs of Parasite of Toucan	„ Mr. C. Le Pelley.
Cells, endosperm of *Phytelephas* (vegetable ivory)	„ Mr. J. W. Reed.

Attendance—Members, 54; Visitors, 7.

February 9th, 1883.—Conversational Meeting.

The third of the series of demonstrations was given by Mr. A. D. Michael, F.L.S., F.R.M.S., in the form of a lecture "On Sea Side Collecting."

In introducing the subject the speaker remarked that as they were not favoured with the ocean in Gower Street he could not demonstrate anything. His object was to afford the younger members some information which could not be found in the text books

A practised shore collector had his own habits, by which he could get on much better than by hints from others. To such his remarks would be useless; but to a person of little or no experience, that acquired by an older

collector might be of service. He intended to make his remarks exceedingly elementary.

Supposing a person intended to start in the autumn for the sea side in order to collect objects for the microscope, he would urge him to endeavour first to become something of a biologist, so as to understand what he was collecting, and not merely to obtain a number of pretty objects. If fewer in number were obtained, those, if well understood, would be far more valuable than a larger collection of badly selected specimens which were not understood. He would advise him to study the various creatures, first taking the widest scope, afterwards a more special branch, and the result would give pleasure and instruction.

The first point to consider would be *where to go.* Probably that question would be a great deal affected by personal considerations, but if a choice of locality were afforded by all means choose a *hard rock* coast. The water comes to the shore clear, and the specimens are consequently beautifully clean. Objects collected in dirty water would of course be covered with dirt. Granite shores usually border very clean water, containing equally clean specimens. All hard rocks are not equally favourable. Granite is the king of rocks for collecting, not perhaps for quantity, but for good condition of the specimens. Granite also stands out boldly into deep water, and the creatures collected are healthy. Graywacke and the harder limestones are very good. Slate *on edge* is also good collecting ground, and the objects are easily obtainable, but do not come up in as good condition as those from granite or other hard rock. The granite coasts are the Cornish, where there are hundreds of miles of it, the Channel Islands, and some part of the Irish coast. By granite is meant all the granitic formations. Serpentine is not bad, but it does not wear into holes, which give shelter to the creatures. For a similar reason Basalt, although very hard, is an exceedingly bad rock, the waves sweep everything off it.

Collectors, however, need not be discouraged who cannot get to a hard-rock coast. Plenty of good things can be obtained on every shore. Chalk is probably as bad as any formation, but his first experience was a winter at Brighton, and he had still a large series of specimens he collected there that winter, at which he often looked with surprise.

Outfit is the next consideration. That must necessarily be influenced by the place selected. One could not walk about Ilfracombe or Torquay in the costume most suitable for work on the rocks, for which there is nothing like a jersey, an ordinary fisherman's jersey. He preferred it greatly to a shooting coat; with such a coat if the collecting bottles were put in the breast pocket, and such other things as were required in the tail pockets, as is usually done, and the collector knelt or stooped down at the edge of the pool to examine it, as he must do, it would generally happen that the bottle in the breast pocket would be found empty, the inverted position of the upper part of the body having produced that result, and the lower part of the coat including the pockets, would be soaked in the pool, and the contents not improved by the bath. Another disadvantage of carrying bottles in the pockets is that they get hot, and the creatures die. To bring home specimens in the best condition they must be kept cool. That is absolutely necessary.

Another point in outfit is *boots*. Each man must exercise his own discretion whether he wants to keep out the water or not, but the question of nails or no nails is a general one. A skilful climber would probably prefer nails in the boots, but to an unpractised one nails are dangerous on hard and smooth rock. He would rather advise the tyro *not* to have nails in his boots.

The cap or hat should be thick, this often saves the head among the rocks the brim should be narrow, a wide one gets into the water.

The best microscope for seaside work is Stephenson's Binocular. It is more convenient than the ordinary Wenham Binocular, as objects in fluid can be examined on a horizontal stage without craning the head over the instrument, but the prisms were usually not fitted strongly enough for carrying about much. The short body (Hartnack pattern) is a convenient form. He carried a Stephenson's Binocular and one of Swifts' portable Binoculars. The Stephenson's microscope was a delicate instrument, and required more care than others.

Two or three cold chisels and a hammer were necessary, a couple of short chisels and one long one, to each of which a stout piece of string should be tied two or three feet long, which could be twisted round the hand which was left at liberty. If the chisel or hammer was dropped into a pool the string would float, and it would be easily recovered.

The hammer should be strong, the geological pattern is best, and the head must be well fixed on.

Two or three glass syringes would be useful for cleaning and mounting specimens, and for aërating living objects in water. A few beakers which pack in nests one within the other, are very portable and useful. These are made of extremely thin glass, and objects can be examined through the side very easily. They make excellent temporary aquaria. A few pieces of clean slate may be put at the bottom. A supply of watch glasses, as large as possible, is required.

If bottles were not carried in the pocket, an ordinary marketing basket answered every purpose. The stiff brown basket slightly constricted in the middle, where the curved wooden arched handle going from side to side is inserted is the best ; the arm is passed through this handle. The bottles should be packed in the basket with wet seaweed to keep them cool.

A pond stick would be useful, if it could be carried conveniently, to cut and drag up seaweed from deep pools.

Whitaker's Almanac is another essential ; in it is a table of the tide *constants* showing the difference of time in the tide between London Bridge, and practically every other part of the country ; also a table of daily high tides at London Bridge, and with these tables it is easy to calculate the tide in a far more accurate way than by inquiry on the spot. Fishermen usually are not accurate within half an hour. It must also be remembered that, with a strong wind, the tide would vary, and inquiry should be made if the tide was generally before or behind its time. In some places the current beats the tide. The tide is higher with strong on-shore winds. After once or twice observing it is easy to calculate how much the current beats the tide.

If it be desired to bring the specimens to London and to keep them alive there, the aquarium must be prepared before starting. It should be got ready a month beforehand. If no growing weeds are to be had, put some ordinary sea water in a glass jar and stand it in the sun for two or three weeks, when enough germs will have been deposited to keep the water sweet and be quite ready for stocking on the collector's return. Move it out of the sunlight into permanent shade before putting in living animals.

Having reached the place, it is very desirable to live as near the collecting ground as possible, so as to run in and out without loss of time, and examine the specimens in the best condition. It is not of any use to collect a mass of things which cannot be examined. The way to get good objects and good observations is to go out for short periods at the best of the tide, bring home a small quantity, and examine immediately whilst in vigorous life.

The collector should remember that, if carelessly pursued, shore collecting becomes dangerous, and these dangers he must avoid. The principal ones are—1, being caught by the tide; 2, being washed off the rocks by large waves; 3, falling on the rocks.

Being caught by the tide may happen in several ways. Some of the most common are the following, viz.:—1, when collecting in a crescent bay with inaccessible cliffs, the tide may creep up unobserved round the headands which form the ends of the bay; the collector should observe beforehand whether these headlands can be passed at all states of the tide; if not, whether the cliffs can be scaled; otherwise he must leave ample time to pass the headland before the tide comes:—2, on collecting on the furthest out uncovered rocks, the belt of water between them and nearer rocks, which was easily crossed when he came out, may have become too wide to step or even to jump, and the rocks may be too slippery or otherwise unsuitable for the latter process:—3, the tide will sometimes rise very slowly up a steep part of the beach, and then run very rapidly along a flat part. Large waves must be avoided by not collecting where they reach and it should be remembered that on many ocean coasts single exceptionally large waves occasionally un in during the ebb tide, particularly when the wind far out is rising, although there may not be any wind near shore.

Falling on the rocks can only be avoided by careful climbing, and by not being in a hurry. It is best for two persons to go together, as one alone, if he sprain his ankle, or have some trifling accident, may be helpless, and not able to get assistance.

A hint or two on the climber's art may be of service. It is necessary to be a fairly good climber to collect with success. Do not take a stick, unless for fishing in pools. Do not trust to a stick in descending steep places, the stick is apt to slip and let the traveller down on his head. It is better to trust the well-balanced position of the body.

In descending steep ocky cliffs, choose the narrowest split in the rock that will serve, not the larger ones. Almost every inexperienced person chooses the larger split but he is not so likely to slip in the smaller one. It is often easy to get up apparently inaccessible rocks by the old Alpine method, doubling the elbows, laying the doubled arms flat on the top of the

rock, the elbows pointing outward, giving a little spring, and throwing the chest on to the rock as you scramble up.

A towel in the hand, or a thick pair of Ringwood gloves is useful in climbing rocks, as it enables the hand to be placed on a rock with sharp points without injuring the skin ; it is well to keep the skin as unscratched as possible, as scratches make the hand stiff. Slippery slopes of rock, if not too steep, may be descended with short outward steps, scraping the feet along the surface. These may, if short, be ascended with a rush.

When collecting, always keep the bottles out of the sunshine, in a shady place ; if possible, sink them in a pool where the water is not quite high enough to run in, this keeps them cool. Take care to mark the spot by some conspicuous object, or it may be difficult to find it again.

Take the specimens home while alive and examine as soon as possible. It is impossible to make good mounts unless it is known what the living creature is like. It is like drawing the human figure from a mummy.

Next as to the best collecting places, and the period for work. The best collecting is done at the lowest tide. Every foot that can be got is of the greatest advantage. Everyone knows that there are two high and two low tides in the lunar month—the spring and the neap. The spring tides are the highest and the best for collecting. Those at the equinox are the lowest, but they often come with wind, and therefore a fairly low tide should not be neglected in hopes of getting a better one at the equinox. The difference in the run of the tide in a rough sea and a calm sea is considerable ; a calm sea is necessary to get to the lowest mark. Follow the tide down, and finish at the lowest point. Keep a good look out and take care not to be cut off by the returning tide.

Do not waste valuable time in collecting at the low tide what can be got just as well higher up. Practice will soon enable one to distinguish the forms found *only* on the lower rocks.

As to places.—There are several modes of collecting, excluding dredging. First, reefs of rocks and the caves. Secondly, rock pools. Thirdly, wreckage. Fourthly, floating stuff of various kinds.

On a reef of rocks observe if there is a ridge running out into the sea a long way with caves or chinks in the sides, a little protected from the sea. It must not be where the waves sweep over every part with their full force at every sea. The further out the ridge extends, and the greater difficulty there is in getting to it, the more will probably be found upon it.

A large rock may sometimes be found fallen down, and partly supported by two others, forming a species of cave, with a few stones in the opening partly blocking it up. The waves run through, but except at low tide the whole is under water. At low tide it is a pool below and a cave overhead. Its sides may no doubt be troublesome to get at, but extremely prolific. Hanging from the roof, and sticking to the sides, will be found all sorts of creatures. Partial caves of that kind, where the sea is continually running in and out, are extremely good. There are caves at Sark which are only open at the lowest spring tide ; such places furnish specimens not to be found elsewhere. As a rule caves high up the shore are not good places.

Rock Pools.—In the long slate ridges, and in the granite and most other rocks, the sea has hollowed out pools, with edges fringed with coarse fuci, underneath which are the red weeds and zoophytes. On first looking into the pool nothing can be seen, but gradually a great deal will be made out. At the lowest edge and in the holes and crevices of these pools a great many things are to be found. These are, on the whole, about the best places to search for specimens.

Many people find a difficulty in looking into the water, especially in pools, as the slightest breeze ruffles the water, and the light is thrown up from the water in a very peculiar and dazzling way. It is possible to get over this difficulty by what the fishermen call a water-glass, which is used for getting up wreckage and spearing flat fish. It is a mere square box or tube of wood, of a sufficient size to allow the face to be put in at one end, the top, which is left open, the bottom is fitted with a piece of common window glass. One side is longer than the others, and has a hole in it for a handle. The glass is pushed a little below the surface of the water, and when you look in, burying your face in the hollow, it takes off the glare of the light, and the bottom can be seen with surprising clearness, but it is a cumbersome instrument to carry about. Another way of collecting is to take a bucket and empty the pool, if sufficiently small, and sufficiently high up. If it cannot be emptied the water can be lowered so as to expose the sides which are permanently covered, until artificially emptied. A bucket is awkward to carry, but indiarubber buckets are made which are very handy for this purpose, and such a bucket enables one to dispense with a basket.

Wreckage.—Under this general term are included many things. In the first place if a storm occur on shore it will tear up the great *Laminaria* and other weeds, which come in with the storm, and if the shore be examined immediately after the storm it gives capital results. The roots are so large and strong that they bring up a great deal of good material. It is useless to look over weed that has been washing about on the shore for two or three days. It must be examined the day after the storm. The storm must not be merely the wind-wash on the top of the water as the sailors call it, but when the waves are large with a good distance between wave and wave they plough up the bottom, and the next morning will yield a good harvest. Another kind of wreckage consists of pieces of wood and stuff that come up from the bottom, which are extremely rich. As a rule, however, it is difficult to get the trawlers to bring in the rubbish, but they bring in wreckage for the copper bolts, which are worth money. If you make friends with them, they will tell you when they have any wreckage. Wood is much better than iron. Lost anchors, &c., sunk in deep water are profuse in living objects, but specimens off iron are usually covered with black oxide which it is very difficult to get rid of. In Jersey at certain times of the year the seaweed is cut and dragged in with rakes for manure; if examined as soon as it comes in a great many interesting things may be procured from it. Floating pieces of cork often have a great deal upon them. Beyond this the best thing is some method of scraping the bottom. Watch for the crab-pots as they are brought ashore (occasionally), or far better go out with the

men and examine the pots as they come up. On the bottom and just inside, whole masses of good things may often be found in comparatively deep water, *i.e.*, 15 to 40 fathoms.

Mr. Michael then exhibited a stone covered with a variety of objects, which he said fairly represented the condition of stones from a crab-pot thrown into the sea by the Wolf Rock, Cornwall. Another way of scraping the bottom in an experimental way is to take a long piece of wood, weighted so as to sink, with a rope at each end, and with a number of pieces of stout string attached, each fitted with a strong cod or conger hook upon it. If trailed after the boat an astonishing quantity of things may be got up from the bottom. Spider-crabs and scallop shells often have quantities of hydrozoa sponges, &c., growing on them.

Go out with the fishermen when they take up the long lines (for flatfish, &c.) ; those lines bring up, adhering to the flatfish, a quantity of the parasitic crustacea which makes our friend the *Argulus* look quite harmless in comparison. On the smaller red seaweeds growing upon the larger are many beautiful specimens. Put the seaweeds into pure glycerine, and they may be brought home in fine condition, fit to mount. The cells do not collapse or swell from exomosis and endomosis. On the finer weed will be found hydrozoa and polyzoa. On *Chondrus crispus*, known by its beautiful metallic blue colour, at the tips of the pinnæ may be found *Plumularia cristata* (*Agloaphenia pluma*), a lovely object, parasitic on many of the finer forms, as *Setacea*. The coarser weeds will be fringed with *Laomedea*, which is also found on buoy ropes in clear water, in fine growth and good condition, swarming with minute crustacea, the curious sea spiders (*Pycnogonidæ caprellidæ*), and a number of kindred creatures, such as *Idotea*, *Pho'o pedata*, &c. *Cellularia ciliata*, a charming object, is found, looking like drops of blanc-mange, hanging from the tops of caves and on the crab-pots. *Bugula avicularia* may be found on the woodwork of piers, &c. It is frequently found at Ramsgate. *Notamia bursaria* and the *Crissias* are thrown up on the shore at Brighton and other places after a storm. The boring shrimp (*Tenais vitatis*), a most beautiful polariscope object, may be found in old floating wood if cut up. Another good plan is to put small pieces of seaweeds into glycerine; a number of crustaceans may be found at the bottom of the bottle. These should be mounted in glycerine. A plan adopted by Edwards is also very successful. Place little bundles of hay in marked places ; leave them for a day or two, then take them up and put them in a bottle. Whenever weed, &c., is collected it is best to take home small quantities, and examine while fresh. The first general examination should be made with a simple microscope. On the roots of the *Laminaria* small barnacles are found, which are excellent microscopic objects. The coating of sponge often found on so many rocks furnishes good specimens of young starfish, *Ophiocoma* and others, which are not commonly found. *Antedon rosacea*, *Ophiocoma*, *Asterina gibbosa*, and young *Echini* may be found in the crab-pots. Holothurians should be sought for under stones. Annelids may be got out of seaweed in much the same way as crustaceans. *Sabella* can generally be found in the splits between

slate rocks. All these form fine objects. *Eolidæ* may be got on the cork buoys, by separating the corks one from another. If placed in a watch-glass in the sun these are a most beautiful sight, but must not be left there long.

On many of our coasts, when there is a calm sea and an outward wind, minute molluscan shells may be found in great quantities. The very small ones are extremely delicate and interesting. The extremely beautiful *Patella pellucida* may be found on the fronds of the great Laminaria. The young patella are on the fronds. If the old patella be wanted one may generally be found in the hollow of the root, but it will be no longer beautiful.

On many of the rocks small light brown or yellowish semi-transparent jars may be seen closely packed together and standing on end. These are the eggs of the Dog Whelk. If brought home and kept in sea water they will probably hatch out in a day or two, when the ciliated larvæ will be very interesting. *Licmophora flabellata* may be found in the very shallow pools not above an inch or two deep in the lowest flat rocks, where they may be found at the very lowest tide, and appear like tiny fringes of yellow or brown fur, too fine almost for the individual threads to be seen. Having brought it home, examine and lay it out under a low power.

Young Nudibranch moluscs may be found crawling among the weeds, and Hydrozoa—some of the genus *Doris*, when young enough, form beautiful and interesting slides on account partly of the arrangement of spicules in the dorsal skin—*Doris aspera* is particularly attractive. The obtaining the radula (the so-called tongue) from *Gasteropods* affords endless amusement, and a great amount of instruction ; it is not very difficult even with small forms, or young specimens, after a little practice. Begin on a limpet, which is extremely easy, thus learn the appearance, &c. ; rely on cutting out, not boiling down with chemicals. Most interesting objects are obtained by towing a small hoop, one side very slightly weighted, and with a coarse canvass conical bag attached, a small portion at the bottom of which is lined with fine muslin, and should have three equidistant strings attached These are held in the hand, and the net flung over the stern of the boat ; row or sail gently, and at short intervals haul up the net, turn it inside out, and wash off the contents into a small collecting bottle of sea water, or a bottle may be used instead of the muslin for very small forms. Crustacean and other larvæ, and beautiful *Medusæ, Beroë Cydippe*, &c., may be got this way. A warm afternoon when he sun is bright and the sea calm is best.

On some of our south western coasts the *Pharsalia* (Portuguese man-of-war) may occasionally be found cast on shore alive. If placed in a large tub of sea water it is a splendid creature, but the collector must avoid allowing the tentacles to touch his skin, or a very painful irritation will result.

If Actinea be desired for an aquarium, the common *mesembryanthemum*, also *gemmacea*, and often *troglodytes* may be got off the rocks with one's thumb nail, or a penknife. *Gemmacea* is found on low rocks and in pools, often on detached stones which are convenient; *troglodytes* are on flat rocksat

the lowest tide mark, and on stones in the crab-pots, and *Laminaria* roots, from which also may be obtained *rosea, miniata, nivea,* &c. Cut the root up, or tear it to pieces, they will be found inside ; *Bellis* is in narrow chinks in rock ; it must be chiselled off, unless the rock be slaty and can be split; *clavata* is chiefly found at Weymouth, and must be chiselled off very hard flat rock. *Corynactus* must be brought home with the rock it is on, not detached ; *Dianthus* (*Plumosa*) comes from deepish water, on the southern coast, but is found plentifully in the Sark caves. All these live well in the aquarium without constant aeration of the water. *Crassicornis* and *Anthea cereus* are easily obtained in pools, or the former in sand, but do not live well without aeration ; the same is true of *parasitica* (found by dredging), *Adamsia*, &c.

To prepare hydrozoa and polyzoa, &c., with extended tentacles, osmic acid is a favourite process, and it gives good results, but it stains too much. The objects should be got in good condition, placed in a watch glass, and syringed freely, and then placed under a low power of the microscope and watched until the tentacles are well extended, then with a fine pipette run a small drop of spirit down the *side* of the watch glass, not on the polype. The creature will probably withdraw its tentacles. If so leave it alone until they expand again, without disturbing it run another drop down the glass. After doing this once or twice the creature gets dull and heavy, drunk in fact, and then spirit may be added freely and the polype mounted. That raises the serious question in what medium to mount it. Spirit and water gives very good results, possibly the best on the whole, but Goadby's solution preserves the creatures in more natural form and keeps the sarcode harder, presenting a more life-like appearance; but it is open to the objection that it contains corrosive sublimate, which produces a certain amount of discoloration of the creature after a time.

[A slide, which had been prepared in this way for two years, was placed on the table] ; this showed a certain darkening of colour which would probably increase. Another objection is that Goadby's solution had a tendency to cast a sediment. For that reason it should be used weaker than the book strength, adding about three times the quantity of distilled water. Seaweeds are best mounted in pure glycerine, Annelids in glycerine or Goadby's solution, Echinoderms in balsam.

The speaker now said that he had been requested finally to touch upon two subjects not connected with shore collecting. With reference to getting creatures, such as insects, acari, &c., in the best condition to mount, he had been asked if he bred them for this purpose. He did so occasionally. Many objects, such as the antennæ of the male gnat, could be got in the best condition by placing a piece of gauze over a water butt. Breeding may be advantageous when pupæ can be obtained in a late stage, or when a rare larva is found. But it is extremely difficult to imitate the whole natural conditions for any length of time, the creature is not strong and vigorous ; and though the hairs and setæ are less injured, it does not necessarily make a better mount than a hardier well developed creature bred in a natural state,

and perhaps caught only a short time after emerging. His own habit was rather to rely upon capture and not breeding.

He had also been asked to say a few words about balsam mounting. The truth, he said, was that he had nothing to tell. So far as his own experience went there was no royal road to success. With care and attention any of the ordinary processes seemed to answer nearly equally well. His own results were obtained simply by care and attention. He did not believe in dodges. Some processes had advantages over others, but people who expected royal roads would probably not find them. They must rely upon their own skill for better results. His chief instruments [holding up some very small pieces of wood] were simply single badger's hairs and very fine needles fixed in lucifer matches. They were easily made and inexpensive.

To mount insects, &c., in balsam, first kill the creature in hot water or spirit. Hard insects and *Acari* were best killed in hot water, which caused them to expand their legs. But water rather injured minute flies, and spirit was better for them. Next wash the objects thoroughly in spirit and clean with the badger's hair, clean mechanically and by washing in spirit. Place the object on a glass slip and arrange it with the hair, leave it in spirit for such a time as experience suggested, tilt the slip so as to drain off the spirit, but not to dry the object, which should never be allowed to dry from the first process to the final mounting. Having drained off the spirit, drop on the object a little oil of cloves, which is better than turpentine; slightly warm the slide and put on a thin cover glass, which must be supported so as not to touch the object; leave it until thoroughly soaked. If necessary remove to a clean slip for the final mount. It may be necessary to arrange the object more than once. Drain off the oil of cloves and put on a small quantity of Canada balsam. He preferred balsam and benzole. Arrange the creature on the centre of the slide. Let the balsam harden a little, then the object will not float off, as happens sometimes when a quantity of balsam is used at once. Lower the cover straight down on the object; do not try to drive out a wave of balsam as is recommended in the text books. It is better not to put enough balsam at first to fill the space under the cover, as the balsam supports the cover if it do not reach the edge, but if the balsam reaches the edge of the cover it is apt to draw down the cover and crush delicate objects. A few pieces of thin glass to support the cover are a great protection to the object, or better still a few tiny glass beads. Finish the slide with a ring, Bell's cement or something of the kind, but that must not be done unless the cover be supported in some way. It is not necessary.

On the motion of the President, a vote of thanks was unanimously passed to Mr. Michael, and the following objects were exhibited in illustration of his remarks:—

Cellularia ciliata.

Ptilota sericea, and other seaweeds in fruit.

Plumularia setacea, with extended tentacles.

Minute shells from the shell beach of Port Curnow, in which the shore end of the eastern telegraph is sunk.

Stones, *Gorgonia*, &c., from the crab-pots.

Young spider crabs, with sponges, &c., on their backs (lent by Mr. Priest), &c.

And the following objects were exhibited in the library :—

Sections of shell of *Dentalium elephantinum*	Mr. F. W. Andrew.
Sponge (*Grantia botroides*)	Mr. C. G. Dunning.
Thorax of Blow-fly	Mr. F. Fitch.
Diatoms, *Coscinodiscus excavatus* and *Cestodiscus pulchellus*	Mr. H. G. Glasspoole.
Foot of Emerald Spider (*Micromata smaragdula*	Mr. H. Hensoldt.
Diatoms, *Plagiogramma elongatum* ...	Mr. W. H. Morland.
Palate of *Testacella haliotoides*	Mr. C. Le Pelley.
Section of Stem of *Moringa conconensis* ...	Mr. J. W. Reed.
,, ,, *Gerrardanthus* ...	,,

Attendance—Members, 73 ; Visitors, 6.

February 23, 1883.

Dr. M. C. Cooke, M.A., A.L.S., &c., President, in the Chair.

The minutes of the preceding meeting were read and confirmed.

The following gentlemen were balloted for and duly elected members of the Club :—Mr. Joseph Clark, the Rev. W. H. Dallinger, Mr. F. E. Pearce, and Mr. Isaac Simpson.

The following donations were announced :—

"Proceedings of the Linnean Society" ...	From Mr. T. C. White.
"Proceedings of the Royal Microscopical Society"	,, the Society.
"Proceedings of the Geologists' Association"	,, ,,
"Proceedings of the Natural History Society of Glasgow"... ...	,, ,,
"Proceedings and Transactions of the Royal Dublin Society" ...	,, ,,
"Proceedings of the Belgian Microscopical Society"	,, ,,
"Science Gossip"	,, the Publisher.
"The Analyst"	,, the Editor.
"The American Naturalist"	In exchange.
"The American Monthly Microscopical Journal"	,,
"Challenger Expedition." Vol. 6... ...	Purchased.
"Pasteur's Studies in Fermentation" ...	,,
"Annals of Natural History"	,,
"Quarterly Journal of Microscopical Science"	,,

"Micrographic Dictionary." Part 20. ... Purchased.
"Cole's Studies in Microscopical Science." Nos. 39-41 ... ... "

The thanks of the Club were voted to the Donors.

The Secretary read a letter of thanks from the Medical Union Society for assistance rendered on the occasion of their recent Soirée by members of the Club.

The President read the following communication from Dr. Partridge, describing the peculiar Silk Weed (*Asclepias Syriaca*), specimens of the seeds of which were sent to the meeting for distribution, the description being extracted from the U.S. *Pharmacopeia*—"Simple stem 3 to 5 feet high, with opposite lanceolate oblong petiolate leaves, downy on the under surface; flowers large, purple colour, sweet scented, arranged in two or three nodding umbels; nectary indentate, pod covered with prickles, containing a silky down, used as a substitute for fur, in the manufacture of hats and for feathers in beds and pillows. Common in United States in sandy fields and roadsides. Flowers in July and August. Gives out a white fluid when wounded (milk weed). Root used as a medicament in asthma and fever, also formerly given by the planters in scrofula. Another species used as a remedy in snake bite in the form of infusion—Soporific and anodyne. Also just introduced as an ornament with artificial flowers for ladies caps and bonnets."

Mr. J. G. Waller read a paper "On an undescribed Sponge," illustrating the subject by drawings on the black board.

The President, in proposing a vote of thanks to Mr. Waller, said he could not help remarking on the use of keeping one's eyes open at the seaside, and especially on the use of examining well the roots of the larger species of Laminaria, which were washed up by the tide, and upon which so many good things were often found—a hint which young collectors would find extremely useful.

Mr. A. D. Michael described by means of a drawing on the board the points of interest in a slide which he exhibited in the room—a dissection of the female sexual organs of one of the Oribatidæ.

The Secretary said that members need only look at these preparations to judge of their extreme beauty and value; the difficulty of their production could hardly be imagined, for the external portion of these creatures was so exceedingly hard, and the internal organs were so very soft, that it was a matter requiring the highest manipulative skill to dissect and mount them.

The thanks of the meeting were unanimously voted to Mr. Michael for his communication.

Announcements of meetings, &c. for the ensuing month were made by the President, and the proceedings terminated with the usual Conversazione, at which the following objects were exhibited :—

Resin and turpentine vessels in husk of pine seed ... ... Mr. F. W. Andrew.
Selected Foraminifera from Connemara ... Mr. H. E. Freeman.

Reproductive organs of female *Cepheus tegeocranus*	Mr. A. D. Michael.
Daphnia Schœfferi	Mr. T. S. Morten.
Bloom of *Masdervallia sp.*	Mr. F. A. Parsons.
Melicerta tyro...	Mr. C. Le Pelley.
Trans. sec. leaf and stem of *Hakea* ...	Mr. J. W. Reed.
Long. sec. stem, petiole and bud of ditto ...	"
Trans. sec. Leaf of Indiarubber plant ...	Mr. W. D. Smith.
Diatoms, *Campylodiscus horologium* ...	Mr. G. Sturt.

Attendance—Members, 55; Visitors, 8.

March 9th, 1883.—Conversational Meeting.

The fourth of the series of demonstrations was given by Mr. E. T. Newton, F.G.S., on "Some Methods of Preparing Parts of Insects for Microscopical Examination."

Mr. Newton observed, in his opening remarks, that as these demonstrations were chiefly intended for the benefit of young workers in microscopy, it was not intended to bring forward new methods so much as to show by actual manipulation how certain pieces of microscopic work were done, Mr. Groves having in a previous demonstration fully described the methods of hardening, staining, section-cutting, and mounting.

Mr. Newton then proceeded to show how he had been in the habit of preparing a series of sections of an object, and for this purpose the head of a cockroach (*Blatta orientalis*) was taken. The head, which had previously been hardened in spirits of wine, was imbedded in wax, and a series of slices cut with a razor in a microtome. These sections were placed upon a series of numbered glass slips, and the staining, cleaning, and clarifying done without removing the sections from these slips, on which, after treatment with turpentine to remove the wax, they were mounted in Canada balsam.

Another series of sections were then prepared from the head of a *Blatta*, which had been stained entire, and after soaking in absolute alcohol, and then in essential oil, had been put in warm wax. When cut, these sections only required to be treated with turpentine, and then mounted in Canada balsam.

Mr. Newton next exhibited the model of a *Blatta's* brain, which had been shown and described to the Club in January, 1879 (see "Quekett Journal," Vol. v., p. 150), and explained how, by means of a series of sections, this model had been prepared.

The following objects were then exhibited in illustration of the demonstration:—

Head of *Blatta* stained carmine, brain *in situ.*

Head of *Blatta* stained aniline black, brain, &c., *in situ.*

Head of Wasp stained carmine, brain *in situ.*

Head of Grasshopper stained carmine, showing optic ganglia.

House-fly, longitudinal section through entire body, organs *in situ.*

Formica rufa, longitudinal section through the entire body, organs *in situ.*

The following objects were exhibited in the library:—

Powder from worm-holes in old furniture ...	Mr. F. W. Andrew.
Tetraspores on *Seirospora Griffithsiana* ...	Mr. T. H. Buffham.
Section of jaw and tooth of Kitten	Mr. W. I. Curties.
Diatoms, Toome Bridge deposit	Mr. H. G. Glasspoole.
Sincoryne fruitescens	Mr. W. Goodwin.
Section of Jutland Slate, showing Diatoms *in situ.*	Mr. W. H. Morland.
Trichobasis suaveolens	Mr. T. S. Morten.
Spiral cells, *Pleurothallis tridentata*	Mr. J. W. Reed.
Petiole of ditto	" "
Melicerta ringens	Mr. T. Simpson.

Attendance—Members, 70; Visitors, 6.

March 30th, 1883.—Special Exhibition Meeting.

By permission of the College, a special meeting was held for the exhibition of objects of microscopical interest, which meeting was attended by 156 members and about 150 visitors.

The following is a list of the objects exhibited, as described on the Exhibitors' cards:—

Portion of Echinus	Mr. F. W. Andrew.
Quartz, Aberdeenshire	Mr. J. W. Bailey.
Whinstone, Perthshire	" "
Granite with Garnets	" "
Micro-photographs of the development of the Chick	Dr. G. Berwick.
" " of sections of Leaf Bud (*Viburnum lantana*)	" "
" " " of Leaf, *Hedychium gardnerianum*	" "
" " " of Stem, *Pilularia globulifera*	" "
Astromma Aristotelis	Mr. W. J. Brown.
Skin, muscles, and fat of Congo Snake ...	Mr. E. Bucknell.
Polysiphonia fastigata in fruit...	Mr. T. H. Buffham.
Transverse section ovules of Poppy	Mr. J. W. Cafe.
Circulation in ova of Trout	Mr. D. B. Cazaux.
Ova of Dory, showing matrix	" "
Young Crab, *Porcellana platycheles*	" ,
Matured ova of Prawn	" "
Crystallisation of Chilled Iron...	Mr. G. F. Chantrell.
" Portland Cement	" "
Crystals and Fungus from *Anacharis alsinastrum*	" "
Leaf of *Durio zibethinus*	" "
Zinc Dust from smelting works	Mr. W. G. Cocks.

Megalatrocha albo-flavicens	Mr. W. G. Cocks.
Melitone Coffee (roasted date-stones)... ...	Mr. F. Coles.
Polyxenus lagurus	Mr. A. L. Corbett.
Santonine, polarised	" "
Section of Leaf and Mid-rib of India-rubber Plant	Mr. W. I. Curties.
Lophopus crystallinus	Mr. E. Dadswell.
Desmids	" "
Palate of Snail	Mr. A. Dean.
Moss	" "
Salicine	" "
Diatoms from Hong Kong	Mr. C. G. Dunning.
Campanularia volubilis	" "
Ovules of Lily (fertilised)	Mr. H. Epps.
Csall-fly	" "
Head of Crane-fly	Mr. J. Epps, jun.
Transverse section, Tooth of Ant-eater ...	Mr. A. Fieldwick, jun.
" " Hand of Fœtus (six months)	" "
Phosphorescent Entomostraca from Indian Ocean	Mr. H. E. Freeman.
Spiral Vessels, stem of Dahlia	Mr. H. Glasspoole.
Foraminifera—*Spiroloculina* ending in *Articulina*...	Mr. H. F. Hailes.
Palate of Limpet, *Spirea Japonica*	Mr. H. S. Hancock.
Volvox stellatus and *globator*	Mr. J. D. Hardy.
Grouped sections of Echinus spines, various...	Mr. H. Hensoldt.
Schorlaceous Quartz	" "
Head of Bee	Mr. G. Hind.
Eyes of Spider	" "
Section, lower jaw Shrew Mouse	Mr. J. Hunter.
" nose White Mouse	" "
" head Fœtal Mouse	" "
Acarus from Scale Moss	Mr. F. J. Kitsell.
Vertical and horizontal sections of Pinna shell	Mr. E. Kiddle.
Melicerta tyro	Mr. C. Le Pelley.
Cancer of Rectum (*Cylindroma*)	Dr. J. Matthews.
Micro-photograph, "Punch"	Mr. G. A. Messenger.
Fringed wing, *Tricopterigidæ*	Mr. A. D. Michael.
Empis livida (predatory mouth)	" "
Cresswellia, sp.	Mr. H. Morland.
Parasites of Pine Martin, Ostrich, Rat, Flamingo, Solan Goose, and Horned Owl	Mr. T. S. Morten.
Head of Spider, showing eyes...	Mr. E. M. Nelson.
Heliopelta...	" "
Supposed Algæ in Carboniferous Coal ...	Mr. E. T. Newton.
Head of Grasshopper, showing optic ganglion, &c.	" "

Palate of Periwinkle	Mr. M. D. Northey.
Section of Horse-chestnut	”
Elytron of Alpine Beetle	Mr. J. M. Offord.
Hydra vulgaris	” ”
Eggs— *Cottus quadricornis*	Mr. F. A. Parsons.
” *Gobius niger*	” ”
Amphipleura pellucida, with 1-25th oil immersion object glass, N.A. 1·38, and dry achromatic condenser...	Mr. Powell.
Starch-cells from *Euphorbia splendens* ...	Mr. J. W. Reed.
Growing point with latex cell, *Euphorbia splendens*	” ”
Stigma of *Vinca major*	” ”
British Butterfly with protruding tongue ...	Mr. F. Reeve.
Injection—Duodenum of Cat	Mr. W. Smart.
” Intestine of Rat	” ”
Rock section *Melaphyre*, Heinbach	Mr. G. Smith.
Porphyry, Elfdalen, Sweden, showing fluidal structures	” ”
Section of a Meteorite from West Liberty, Iowa	” ”
Eggs, *Planorbis corneus* (living)	Mr. A. W. Stokes.
Striped voluntary muscle, Human Tongue ...	Mr. J. G. Tasker.
Paramœcium aurelia and *Stylonychia* treated with tannin	Mr. H. J. Waddington.
Stomach of Cat	Mr. W. D. Wickes.
Ovary of Cat	” ”
Trichina spiralis, encysted in Human muscle	Mr. J. Willson.
Hornblendic Granite from Cleopatra's Needle	” ”

April 13th, 1883.—Conversational Meeting.

The fifth of the demonstrations was given by Mr W. T. Suffolk, F.R.M.S., on “ Microscopic Vision,” in one of the College Class Rooms.

In his opening remarks Mr Suffolk observed that he wished to bring before the members some delicate optical experiments in order to illustrate and explain the discoveries made by Professor Abbe some ten years ago, and which up to the present time few people knew anything about, and fewer still believed in.

With regard to microscopic vision, there was a diagram to be found in nearly every book on the microscope, in which diagram the object-glass was represented as forming an image at a certain distance behind it, that image being again magnified by the eye-piece. The diagram was correct so far as it went, but when an object possessing minute detail was examined, no matter whether the structure was lined, dotted, or granular, so long as it was minute enough, another factor came into the calculation, which was known as *diffraction*.

In familiar language, diffraction was the power which light possessed of going round a corner under certain conditions. (This was illustrated by a sketch on the black board, showing that solid opaque substances had the power of bending light, a finely ruled or granular surface also doing the same.) A very familiar example could be seen at night in any railway carriage through the steamy or smeared windows, where curious irradiations surrounded the distant gas lights as seen through the dirty glass.

Now when a microscopic object possessed structural details exceeding a certain degree of fineness, it acted precisely as a ruled diffraction grating, and gave rise to a series of coloured images (diffraction spectra), varying in number and arrangement according to the nature of the structure. These surrounded the before-mentioned pencil of light (Dioptric beam), and joined with it in producing the microscopic image, the function of the *dioptric beam* being confined to the rendering of general contour with a very limited amount of detail, while the *diffraction spectra*, according to Professor Abbe, alone resolved detail exceeding a certain degree of minuteness.

The Professor had devised a few simple experiments to prove the truth of his theory, which, although easily exhibited to one or two persons, were extremely difficult to demonstrate to a large number. He (the speaker) had, however, prepared a series of models or diagrams which would convey a tolerably clear notion of the experiments to those present, and he would afterwards endeavour, with the assistance of Mr Ingpen, to show the various effects with the instruments on the table.

The diagrams illustrating the formation of the spectra, and the shape and position of the slits in the diaphragms by which the spectra were examined, were shown on a scale sufficiently large for those present to see, the various discs being slipped over a blackened background, so that they could be easily revolved and changed as required. [The plate illustrating Mr. Crisp's paper on Diffraction (Plate VII., Vol. v. of the Club Journal), and which is fully explained in Mr. Crisp's paper (see p. 79 *et seq.* of the same volume), will enable the reader to follow the experiments here described.]

Professor Abbe's experiments were made on a known object, with an objective of low power, and under conditions which were entirely under the control of the operator. The objective was Zeiss's "aa, 32 mm. nominal focal length" (about $1\frac{1}{4}$ inches English); numerical aperture $0{\cdot}17 = 20^\circ$ angular aperture. The object was a series of two sets of fine lines ruled on silvered glass, the lower set being twice as close as the upper set. As the dividing engine was employed in the ruling process, the distance of the lines and the exact nature of the object was placed beyond doubt.

The next step was to find some means of examining the emerging pencils at the back of the object-glass. This could be done by removing the eye-piece and looking down the tube, but the most effectual way was that suggested by Mr. Ingpen, the employment of a small Ramsden eye-piece placed above the ordinary ocular, the whole combination forming a small telescope, which gives a clear view of what is taking place at the back of the object-glass.

Supposing the coarser series of lines were focussed for distinct vision and illuminated through a very small circular aperture, upon examining the emergent pencils a white spot of light would be seen in the centre of the field, and on each side of it, in a line perpendicular to the direction of the ruled lines, four spectra with the blue turned towards the centre and the red outside. With the finer lines, which were twice as close together, the dispersion is doubled, and only two spectra are to be seen on each side of the dioptric beam. With an object-glass of greater aperture more spectra are visible, the number being infinite and extending to the margin of the field of the objective used.

Then came the question—Were these spectra of any use in forming the microscopic image? Professor Abbe proved that they were by a few simple and convincing experiments.

A series of diaphragms were adapted to fit a carrier placed in an adapter, so that they could be brought over the back of the objective and easily rotated or changed as might be desired.

The first experiment was to cut off the whole of the diffraction spectra by means of a narrow slit placed as above described. On examining the object the lines had disappeared, only the outline of the rectangular space they had occupied being visible, and it was stated that no amount of mere magnifying power was capable under these conditions of resolving the lines. It might be objected that nearly all the light had been cut off by the narrow slit. That was granted, but upon rotating the diaphragm until the slit was in a position at right angles to the lines and the diffraction spectra were admitted, the lines were then seen as well as before, while the amount of light was the same as in the former part of the experiment, proving that the diffraction spectra had a very important influence in forming the image, and when excluded, detail exceeding a certain degree of fineness could not be rendered visible.

The next step was to try whether individual spectra possessed any special powers in resolving or suppressing structural details.

A diaphragm having a slit somewhat wider than that in the former experiment, capable of admitting the two inner spectra only along with the dioptric beam, was now inserted; the result was that the coarser lines were distinctly visible, but the finer series remained unresolved, which was explained by showing that no spectra belonging to the fine lines had been admitted, therefore no image was formed. Another diaphragm was next used, excluding the spectra last employed, but admitting the next pair, which were the first having their origin in the finer lines, although common to both series. In fact the spectrum of the coarse lines was made to resemble that of the fine lines. The result was more remarkable than in the preceding experiments, both series appeared to consist of fine lines; in the case of the coarser lines a false effect being produced, as they appeared to be doubled in number, a spurious line being inserted between each.

With another diaphragm taking in only the dioptric beam and the two extreme outer spectra, it was possible to produce an image resembling that

of a much finer structure than the real one, the fine lines being doubled and the coarse ones quadrupled.

Proceeding to the examination of more complex phenomena, it was pointed out that the spectra were formed in a direction perpendicular to the lines producing them, and conversely the spectra produced lines perpendicular to their own direction. The phenomena were interchangeable and reversible.

Two series of lines crossing each other at right angles produced a very complex arrangement of spectra, but it would be easily understood by keeping in mind what had been said about the spectra of a series of lines in one direction only.

By using a diaphragm with a slit which admitted the spectra in one direction only, say a horizontal series, it was found that the vertical lines of the grating alone were visible; on rotating the slit 90° the horizontal lines only were seen, and by selecting spectra at an angle of 45° the horizontal and vertical series were invisible, being replaced with spurious diagonal lines. A diaphragm with a cross-slit enabled two sets of lines to be seen, false or true according to its position and consequent selection of spectra.

The experiments demonstrated the importance of admitting all the diffraction spectra which the object gave rise to, in order to see truly the details under the microscope.

The important bearing of the subject with reference to the markings on diatoms was alluded to. One of the series on Professor Abbe's diffraction plate consisted of lines intersecting each other at an angle of 60°; the diffraction spectra produced by this object closely resembled those produced by *Pleurosigma angulatum*.

When with this series of rulings the dioptric beam alone is admitted, the lines disappear as in the preceding experiments, the conditions closely resembling those of *Pleurosigma angulatum* viewed with an objective, say of 50° or 60°, incapable of resolving it. If the examining eye-piece be used, it will be found that no diffraction spectra are contained in the field; therefore, as before shown, no markings are visible. Changing the objective for one of larger aperture, say 80° or 90°, so long as the light is central, the appearance of the emitted pencil is the same as before; but by pushing the mirror aside the dioptric beam can be moved to the margin, and one or two of the diffraction spectra brought into view near the other side. If the diatom is now viewed, one or two series of cross lines can be seen. This explains how, by the old process of skilfully dodging with the mirror, a diatom could be resolved. The peculiar qualities of immersion objectives were briefly alluded to, especially the fact discovered by Professor Abbe that although their angular aperture might be smaller than that of a dry lens, yet they were larger in real and effective aperture, and their capabilities of including diffraction spectra and consequently giving greater resolving power were enormously in advance of any dry objective that could possibly be constructed.

Mr. Suffolk concluded by stating that a careful examination of the condition of the pencils emerging from the back of the object glass would save much waste of time in trying to resolve an object that the glass was quite incapable of effecting.

At the close of his observations Mr. Suffolk, assisted by the Hon. Secretary, exhibited and explained most of the experiments, omitting only a few which were too delicate for successful demonstration under the existing conditions.

The following objects were exhibited in the library :—

Stellate hairs, leaf of Olive	Mr. F. W. Andrew.
Daphnella Wingii	Mr. W. G. Cocks.
Acineta, a form of *Vaginicola*	Mr. Goodwin.
Stentor Mulleri	Mr. H. R. Gregory.
Drilosiphon muscicolum, Stellate hairs, *Aralia papyfera*	Mr. J. D. Hardy.
Trinacria Heibergii	Mr. H. Morland.
Section, Hoof of Zebra	Mr. T. S. Morten.

Attendance—Members, 59; Visitors, 2.

April 27th, 1883.

Dr. M. C. Cooke, M.A., A.L.S., President, in the Chair.

The minutes of the preceding meeting were read and confirmed.

Mr. Wm. Gregory and Mr. T. J. McManis were balloted for and duly elected members of the Club.

The following donations, &c., to the Club were announced :—

"Proceedings of the Royal Society"	From the	Society.
"Journal of the Royal Microscopical Society"	,,	,,
"Proceedings of the Geologists' Association"	,,	,,
"Fourteenth Annual Report of the Liverpool Microscopical Society" ...	,,	,,
"Journal of the Postal Microscopical Society"	,,	,,
"Proceedings of the Belgian Microscopical Society"	,,	,,
"Science Gossip"	,,	Publisher.
"The Analyst"	,,	Editor.
"The American Naturalist"	In exchange.	
"The American Monthly Microscopical Journal"	,,	,,
"Annals of Natural History"	Purchased.	
"Micrographic Dictionary." Part 21, (concluding)	,,	
"Cole's Studies in Microscopical Science." Parts 42 to 50	,,	
One Slide—Hairs of *Aralia*	From Mr. Hardy.	
One Photograph for the Album	Dr. M. C. Cooke.	

The President reminded the members that the excursions of the Club had commenced for the season, and lists of objects of interest found in the Botanic Gardens, Regent's Park, and also at Caen Wood, were read.

Mr. Curties read a letter from Mr. S. Green, of Ceylon, descriptive of some specimens of insects forwarded therewith, and also a short paper "On an Easy Method of Mounting Insects."

Mr. A. D. Michael thought they must not quite take it as correct that a few hours' exposure to the cyanide bottle would be sufficient to destroy the tissues of these insects. The cyanide bottle was so well known to collectors that few were without one ; its great use in addition to killing the creatures being that they could be set without difficulty two or three days after they were first killed as *rigor mortis* did not set in whilst they were kept in the bottle. Of course if they were left *too* long they would decompose, and it was quite possible that in Ceylon decomposition might set in very rapidly. In England, however, they would certainly take no harm during the summer time if kept for two or three days. The plan of setting insects in balsam, from which they had afterwards to be detached, would perhaps do for large specimens, but he was afraid that small ones would not bear the transfer, and thought it would be much better to arrange them with a hair in a medium that would not stick to them, and then to apply them to a film of balsam on the slide on which they were to be mounted.

Mr. Ingpen said that without suggesting that this process would be applicable to insects of all sizes, he could not help thinking that the process described by Mr. Green might be of very great use, especially to those who were collecting insects abroad, and who wanted to send specimens home without getting them injured. If the members would look at those sent by Mr. Green and contrast them with some which were occasionally received from other quarters, the contrast would undoubtedly be in favour of the former ; so that if not universally applicable the process would at least be of great use in many cases. With reference to the naming he could only say that they had already in the cabinet about 150 specimens prepared by Mr. Green, of which a very few only were named, and if they could get them named approximately, say the genera only, it would be of some use in enabling them to be classified.

The President did not see any practical difficulty whatever in the matter of naming the specimens, or any number of specimens. If anyone would separate them a little into groups—say 50 ants in one and 50 diptera in another—he believed he could easily get anyone at the British Museum to name them, especially if there were any duplicates amongst them which might be placed at the disposal of the Museum. They would, he believed, do this *con amore*.

Mr. Michael said he ought not to have omitted to say that he regarded Mr. Green's mounts as the most instructive things of the kind which had ever been seen in this country. Dr. Cooke no doubt spoke from experience, but so far as he himself was concerned he could only say that he had found very great difficulty in getting things named in that manner—everybody at the Museum had to give an account to Dr. Gunther of the way in which

his time was occupied, and there appeared to be some objections raised to this time being spent in naming specimens for people outside.

The President could only say that when Mr. Smith was at the Museum he used to afford every opportunity for this kind of service; but under present circumstances things might not be the same.

Mr. Curties said his own experience in the matter had not been highly encouraging. During the lifetime of Mr. Smith there was always consideration to be had, but at present they seemed to want a proper means of approach. The desire to obtain specimens for the Museum was no doubt a laudable one, but he thought that when this matter was taken in hand on behalf of the Club, it should be entrusted to someone who had some knowledge of the subject, and who would be able to see that all the best things were not cribbed for the country.

Mr. E. M. Nelson exhibited and described a new medical student's microscope, designed to afford a better class of instrument at a lower price than had formerly been offered.

Mr. Michael called attention to a slide which he exhibited of the chelate mandibles of one of the oribatidæ—showing the muscles of the mandibles, and illustrated his explanations by a drawing on the black board.

The President said he had the pleasure of announcing that they were honoured that evening by the presence of a gentleman from New Zealand, Mr. Durrand, who had brought with him a number of specimens to show the members. He offered him in the name of the Club a hearty welcome, and trusted that this commencement of their acquaintance would lead, both for him and for them, to some good practical results.

Announcements of meetings, &c., for the ensuing month were then made, and the meeting concluded with the usual conversazione, at which the following objects were exhibited:—

Rye grass	Mr. F. W. Andrew.
Foraminifera, Diatoms, Palates of Mollusca, &c., from New Zealand	Mr. A. Durrand.
Section of Ovary of Tiger-lily	Mr. H. E. Freeman.
Melicerta ringens	Mr. H. R. Gregory.
Floscularia	Mr. C. Le Pelley.
Mandible of *Oribata*	Mr. A. D. Michael.
Hæmatopinus Suis	Mr. T. S. Morten.
Bacillus tuberculosus, with 1-25th oil immersion object glass, N.A. 1·38	Mr. E. M. Nelson.
Section, Leaf of *Euphorbia splendens*... Section, Leaf of *Dasylirion acrotrichum*	Mr. J. W. Reed.

Attendance—Members, 50; Visitors, 6.

Q. M. C. EXCURSIONS.

List of the Principal Objects Obtained at Keston, May 19th, 1883.

(*Communicated by* Dr. M. C. Cooke, *and read May* 25*th*, 1883.)

Zygogonium ericetorum, Kutz.
Staurospermum quadratum, Kutz.
Mesocarpus parvulus, Hass.
Conferva bombycina, Kutz.
Draparnaldia glomerata, Ag.
Œdogonium delicatulum, Kutz.
Apiocystis Brauniana, Nag.
Tetraspora lubrica, Ag.
Botryococcus Braunii, Kutz.
Raphidium falcatum, Braun.
Hyalotheca dissiliens, Breb.
Micrasterias rotata, Ralf.
Euastrum ansatum, Ehrb.
Euastrum binale, Turp.
Cosmarium margaritiferum, Turp.
Cosmarium cucurbita, Breb.
Staurastrum dejectum, Breb.
Penium digitus, Breb.
Penium margaritaceum, Breb.
Penium Brebissonii, Ralf.
Tetmemorus granulatus, Breb.
Tetmemorus lævis, Kutz.
Docidium truncatum, Breb.
Closterium lunula, Müller.
Closterium turgidum, Ehrb.
Closterium Leibleinii, Kutz.
Closterium costatum, Corda.
Closterium striolatum, Ehrb.
Closterium Dianæ, Ehrb.
Closterium juncidum, Ralf.
Spirotænia condensata, Breb.

On the Work of the Coast Survey and the Fish Commission of the United States.

By Romyn Hitchcock, F.R.M.S.

(*Address delivered June 22nd,* 1883.)

At the Fisheries Exhibition now being held at South Kensington, although the greater portion of the exhibits are outside our province, still there are a great many things which are of a strictly microscopical character. In the United States Department, for instance, there is a fine collection of sponges sent by Mr. Peters, of Philadelphia. Not only is there a large number of dried specimens, but also mounted microscopical slides.

Again, in the Swedish department there is a series of soundings from the bottoms of some of the Swedish lakes, and these, under the microscope, are of great interest, as there are great numbers of portions of entomostraca amongst them, and they throw considerable light on the subject of the food of fishes.

There are, however, few organic forms obtained in this manner at great depths, and more may be done to collect them in the living state by the use of the tow-net on the surface, and the dredge near the bottom. I also think that by conducting these operations by night as well as by day, much additional light would be thrown on the fauna of the fresh-water lakes.

In the aquarium of the exhibition, some of the fishes were found in a diseased condition, and were seen to be covered with flocculent spots. The fish became restless, and tried, by rubbing themselves against the rock-work, to remove what troubled them.

A microscopical examination of these spots showed that they were caused by a species of fungoid growth, which has since been cultivated, and found to be identical with that associated with the salmon disease.

With regard to the exploration of the deep sea bottom, this was virtually begun by Dr. W. B. Carpenter in 1868, and to him science is mainly indebted for much of the knowledge which it possesses on the subject, and it was owing in a great part to his efforts that the "Challenger" expedition was organized.

Among the earliest results of this work was the conclusion reached by Dr. Carpenter in 1869, that there is practically no limit to the depth at which animal life may exist in the ocean bed.

This conclusion was based upon the results of dredgings made during the " Porcupine " expedition, when the dredge was used at a depth of 2,435 fathoms. Later researches have however, shown that there is no life at the greatest depths, where the bottom consists of a very fine ooze, almost entirely inorganic. Any remains of pelagic organisms which may be presumed to live above it are disintegrated and dissolved before they reach the abyssal depths.

The " Challenger " was fitted with a fine collection of apparatus for the purpose of dredging, but most of it was so heavy as to be somewhat difficult to manage, especially at great depths. The more recent introduction of the steel wire rope has enabled dredging to be done with much smaller and lighter apparatus, and has also enabled soundings to be obtained with much greater accuracy.

Since the date of the " Challenger " expedition very little work of the kind has been done by this country. The most important recent investigations of the life and the physical conditions of the sea have been conducted by the United States Coast and Geodetic Survey, and by the United States Fish Commission.

The former has been conducting observations along the eastern coast of the United States, in the Carribean Sea, the Gulf of Mexico, and adjacent waters, the steamer " Blake," fitted with the most perfect apparatus yet devised for the purpose, having, under the direction of Professor Agassiz, been almost continually engaged in the work during the past four years or more.

The Fish Commission has also accomplished much valuable work in studying the natural history and habits of the fishes and other animals living in the United States waters, conducting physical investigations, and in many ways contributing largely to our stock of knowledge. Some interesting observations on the temperature have been made by Professor Verral.

Although the United States Government fitted out a smaller vessel than the " Challenger " for their investigations, they have continued the work for a much longer time, and one of the results of this is that they have a good series of specimens of sea bottom along the whole coast as far as the State of Maine, as well as a series of observations on the Gulf Stream. On the western border of the Gulf Stream a new fish has been found, the so-called " Tile-fish."

It has never been caught with a hook, the reason being that its mouth is so formed that it cannot take one in.

It has been ascertained that this fish lives at depths of from 70 to 150 fathoms on the western border of the Gulf Stream, up as far as the Georges Bank, and this discovery was made by the use of dredges. Not long ago, the fishermen coming in from the Jersey coast and the Georges Bank, reported that they had found a great number of dead fish floating upon the surface of the water in those localities. The fish were of a kind unknown to them, and the descriptions given differed so much as to make it difficult to say exactly what they were. Professor Baird suggested that they might be tile-fish. The cause of their being found dead in such large numbers is entirely unknown, but it was possibly due to some great commotion in the deeper water, though no such phenomenon has been observed and reported upon.

You are probably familiar with the facts observed and recorded by the "Challenger" expedition, and therefore I need not refer to them at any length, but the United States Coast Survey have found that in the distribution of temperature on the bottom of the sea, the water lying in a valley is of the same temperature as that of the current of water passing over the top of it.

The trawls used were made on a somewhat different pattern from those previously in use, having both sides precisely alike, so that it did not matter which side went down first. The dredge employed was one which was introduced by Captain Chester. It is a very ingenious little affair, and the improvements have very greatly increased the value of the instrument. It has an arm extending about three feet, with a simple net placed upon it, so as to be about two feet above the bottom when in use. This is found to collect and bring up to the surface a lot of material which would otherwise escape.

The greatest depth yet reached was from the steamer "Blake," about 100 miles north of St. Thomas, where they marked 4,561 fathoms, and found the temperature to be 36°.

The accuracy of these results has been occasionally questioned. It may therefore be desirable to explain the method used to obtain them. This was to send down a weight of about 36lb., which sank and carried the wire down with it. In this way vertical casts have been obtained, the vessel being still at the time. The line used was fine steel piano wire wound on a drum, which measured just a

fathom in circumference, so that the number of turns gave the quantity of line run out. Sometimes the soundings were repeated in order to test their correctness, and in depths of 1,500 to 2,000 fathoms the results have agreed to within a fathom.

As regards the distribution of life between the surface and the bottom, the "Challenger" observations would show that down to 1,000 fathoms there appeared to be no zone where life did not exist, but on further investigation it seems that these results are not to be depended upon as conclusive, because as the tow-net goes down and comes up again it collects organisms from all depths, and it is not possible, therefore, to say whether its contents come from the bottom or not. This difficulty was understood and acknowledged, but for some time nothing was done to remedy it, until Captain Sigsbee devised what was called a "water trap" for the purpose. This consists of a copper cylinder, with a valve at the bottom opening upwards, and a strainer at the top. It is so arranged that it can be let down to any desired depth, and then, by opening the valve, a sample of the water at that depth is secured. The sinker is first attached to the line in the usual way, and let down to a convenient distance, and a metal stop fixed upon the wire. The "water trap" is then put upon the wire about 50 fathoms higher up, with its valve closed, and the interior filled with water which has been previously strained. The line is next run out until the stop reaches the depth it is desired to examine.

A metal plate is now let down the line, and this, by striking the water trap, opens the bottom valve, and at the same time releases the cylinder, which then runs down the line until it reaches the stop, which arrests its descent, and at the same time closed the valve again.

On drawing the trap once more to the surface they can be sure that the water inside has been taken in from between the points where the valve was opened and where it was again closed.

By these means they have found reasons for concluding that life is confined to a zone near the surface and to another near the bottom, a fact of great interest to those who study the Foraminifera and the Polycistinæ, and a fact which would also naturally refute some of the conclusions of Sir Wyville Thomson. The entire absence of organic remains at the greatest depths has yet to be fully explained. It has been supposed that they become dissolved, but this difficulty remains, that large quantities of

radiolaria *are* found at immense depths, and it has not yet been explained how it is that solution takes place in some localities and not in others.

The sinker used for depths of 1,000 fathoms weighs 34lbs. ; for greater depths a 60lb. weight is used, and is quite sufficient, and seldom exceeded, except where there were very rapid currents. The 34lb. weight is always recovered, but in deep casts it is usual to leave the sinker at the bottom to relieve the wire of the strain of hauling it up.

For collecting small samples of the bottom a sounding rod is used, which consists of a brass cylinder about a foot long, with a valve at the bottom, opening upwards and closed by a spring. When this strikes a sandy or soft bottom some of the material passes the valve, and is thus secured. The sinker is a spherical cast-iron shot, with a hole bored through the middle. The sounding rod fits loosely in the hole, and the shot is sustained on the rod by a wire sling, which extends up to the hook of the detacher. The detacher is a simple contrivance for releasing the shot when the bottom is reached.

The first efforts to obtain the temperature of the sea at great depths gave absolutely no results, because the thermometer bulbs were so compressed by the weight of water, which sometimes reaches several tons to the inch, that the mercury was driven far up the stem.

Messrs. Negretti and Zambra first produced a thermometer sufficiently strong to resist this pressure by forming it with two bulbs, one within the other, the outer one being partially filled with mercury and exhausted of air. After this Cassella applied the same protecting principle to a "Sixe's" thermometer, but used alcohol instead of mercury in the outer bulb.

For a long time the Miller Cassella thermometer, as it was termed, was the only one available for taking serial temperatures. It was made on Sixe's pattern in order to register the maximum and minimum temperatures, but it was not altogether satisfactory, being rather fragile and liable to have the indices displaced.

Another form was therefore devised by Messrs. Negretti and Zambra. This has a bend just above the bulb, and by inverting the instrument the column of mercury parts at this bend.

This instrument is now used almost exclusively. It has only to be placed in a case which can be turned over end for end, this being sent down and inverted at any particular depth. When it is again

drawn to the surface the temperature at the part reached can be read off.

Several methods have been devised for effecting this reversal. Commander Magnagni, of the Italian Navy, and Mr. W. L. Bailey, of the United States Navy, have each applied a principle which has been used for various purposes in deep sea work.

Above the case enclosing the thermometer is placed a miniature propeller. As the apparatus descends this propeller does not revolve, but when the apparatus is drawn up the propeller makes a certain number of revolutions, and then unlocks the thermometer, which, being top-heavy, turns over.

By attaching a number of thermometers at definite points on a line they may be sunk and then read off as they are again hauled on board.

Another plan of inverting the thermometers was devised independently by Captain Rung, of Denmark, and by Mr. Bailey. This was to send a weight or messenger down the line after the thermometers have reached their places. When this weight reached the first thermometer it caused it to turn over, and at the same time released a second weight, which ran down the line and inverted the next instrument, and so on throughout the series.

For collecting samples of water for analysis the latest device is Captain Sigsbee's water bottle, which has been used with perfect success for several years. It consists of a brass cylinder about 15 inches long by nearly three inches in diameter, with poppet valves at top and bottom, opening upwards, and connected by a central rod. As the apparatus sinks the water freely enters at the bottom and flows out at the top. On ascending, however, the valves close, and a propeller wheel above comes into action, and soon engages with a screw, which runs down upon the upper valve, seating it firmly, and preventing any possibility of opening by accident during ascent.

THE PRESIDENT'S ADDRESS.

On Biological Analogies.

Delivered at the Annual General Meeting, July 27th, 1883.

By M. C. Cooke, M.A., LL.D., A.L.S., &c.

It is no longer possible, within the limits of an annual Address, to summarize the work in which the microscope has been the medium of investigation during the year. A catalogue of books, memoirs, and communications would scarcely prove "light reading," and, however useful practically, is not the direction in which your President would desire to expend his expiring energies at the close of his term of office. The alternative which I have selected may not be a theme of thrilling interest, nor one replete with novelties. It can lay claim to little more than making use of the labours of others, by stringing together a series of facts, inferences, and suggestions, with no claim to originality beyond the form in which they are presented. All that I desire to perform is to compress within moderate limits some materials for thought and reflection, which may perhaps furnish the filling up of such stray half hours as you may possess in the next two or three months of the year, when many of you will find yourselves enjoying a temporary release from the cares and anxieties of every-day life at the seaside, or strolling along green lanes. Under such circumstances, brought into closer relationship with natural objects, in a natural condition, it may prove a pleasing relaxation to trace "Biological analogies," and correllate the harmonies of Nature, and realize that—

> For his gayer hours
> She has a voice of gladness, and a smile
> And eloquence of beauty; and she glides
> Into his darker musings, with a mild
> And healing sympathy, that steals away
> Their sharpness ere he is aware.

The analogies which may be traced in the animal and vegetable kingdoms, as far as they were then known, were made the subject of comment a century ago, and consequently anterior to the most re-

markable revelations of the microscope. Soon after Trembley's experiments on the Hydra, an octavo volume was published on the Analogies in Reproduction in the Animal and Vegetable Kingdoms,* for which the Hydra served as illustration. What a far greater number of analogies could be cited now than were dreamt of in 1790. We still know as little of the mystery of life as was known then, and probably the century to come will not teach us much more. But of the phenomena of life we are constantly accumulating new facts—and after all we know nothing of life but its phenomena—these new facts serving more and more to demonstrate that life is the same whether manifested in an animal or a plant, that the phenomena are the same, making allowance for varied conditions, the struggle for existence the same, and the ultimate aim, the perpetuation of the species, equally manifest in both.

Naturally enough we turn first to the beginnings of life, not the abstract "origin of life," but the beginning individualized. The first germ of the plant, the oak, the wallflower, or the minute water-weed; the first germ of the animal, the ox, the robin redbreast, or the *Vorticella*, and in all we revert to the simple cell. Professor Huxley expressed a biological fact when he wrote—"It is now proved that every plant begins its existence under the same form; that is to say, in that of a cell—a particle of nitrogenous matter, having substantially the same conditions. So that if you trace back the oak to its first germ, or a man, or a horse, or lobster, or oyster, or any other animal you choose to name, you shall find each and all of these commencing their existence in forms essentially similar to each other; and, furthermore that the first processes of growth, and many of the subsequent modifications, are essentially the same in principle in almost all."† In the lowest forms of life it is not only extremely difficult, but often impossible, rightly to determine from the single cell what the future organism will be. This difficulty was the basis, or at least gave colour to the theory that the same germs produced now an animal and now a vegetable organism. Had it not been for the identity in appearance of the simple germs of the simplest organisms, the theory of heterogenesis would never have been propounded, or would much sooner have been brought to confusion. This is one of the controversies which is now a matter of history.

* "On the Analogy between the Propagation of Animals and that of Vegetables," by Dr. J. Parsons, 1752.

† Huxley, "Lectures on Organic Nature," p. 26.

Pass but a little further and we encounter another series of analogies. We are most of us acquainted with those extraordinary forms of animal life in which a single cell performs all the essentials of locomotion, absorption, digestion, and excretion. Those simple rhizopods with which but for the microscope we should have remained in ignorance, the *Proteus* or *Amœba*, as elsewhere described, "is in fact a little lump of jelly, and scarcely anything more. It has no mouth, no eyes, no legs, no hands, no feet, no stomach, yet it performs the functions of all these. No mouth, yet it extemporizes a mouth from any portion of its surface, involves and draws in its prey; no legs, yet it elongates and pushes out any portion of its gelatinous substance like a leg to move itself about; no stomach, yet it takes food, and gathers it into the midst of its gelatinous mass, digests it and rejects the undigested portion. Now it is almost spherical, then it becomes oblong, lengthens itself into a long and narrow body, and then as speedily becomes triangular, or star-shaped, or many-sided. In fact it is a very Proteus, every instant changing its form, and assuming every shape of which a plastic lump of gelatine is capable." This creature is recognized, without doubt or demur, as a member of the animal kingdom. Yet there are similar organisms developed in one stage of the existence of those controverted fungi known as *Myxomycetes*, but which were sought to be transferred to the animal world under the name of the *Mycetozoa*, chiefly, if not entirely, on account of this Amœbiform stage. In a recent work on Infusoria, admirable and useful as a whole, this fallacy is insisted upon: "A primary flagelliferous phase, an intermediate repent amœboid condition, an encysted sporiferous state, these three represent the normal life-cycle of either a Myxomycetan or a simple monadiform animacule," and for these reasons it is concluded that "these organisms have nothing to do with Fungi, but are rightly referable to the Protozoic division of the animal series" (p. 472). Rather than adduce any argument from organisms, the systematic positions of which are disputed, let us see if any analogous conditions cannot be found elsewhere. That simple unicellular Alga now known as *Chlamydococcus pluvialis* consists of simple subglobose cells. The life history of this organism has been the subject of protracted study, and no one doubts that it has "a primary flagelliferous phase, and a final encysted sporiferous state." In our Journal for 1879, my predecessor in this chair relates his

experiences of the changes he saw taking place from the simple Protococcal cell to the Amœboid form. The details can be referred to of this completion of the cycle of "a flagelliferous phase, an amæboid condition, and an encysted sporiferous state," and yet we are not aware that *Chlamydococcus* has been referred to the "Protozoic division of the animal series."

We all know *Volvox globator*, but we have not all of us seen it pass through the Amœboid stage, and yet Dr. Braxton Hicks ("Trans. Micr. Soc.," 1860, p. 99) describes this stage, when the cells "have a curious power of changing shape, like an infusorial Proteus, protruding the wall, first at one side and then at another, into which protusions the contents pass." A year or two subsequently these observations were confirmed by the same author in a most interesting paper ("Quart. Journ. Micr. Sci.," 1862, p. 96), with additional details. "It has the power of protruding and retracting, in various parts, portions of the primordial utricle, exactly and to the full extent of a true *Amœba*. By this power they glide along the inner surface of the sphere among the unchanged zoospores, and when they come in contact with one they bend themselves round it in the manner of the *Amœbæ*."

Another observer, Mr. Archer of Dublin, has traced the development of Amœboid forms from another undoubted unicellular Alga (*Stephanosphæra pluvialis*). "It will readily be believed that my astonishment was beyond measure great," he writes, "upon, beyond all question, identifying these vigorously active Amœba-like bodies with the, just previously, quiescent primordial cells of the *Stephanosphæra*—nay more, in watching the transformation of the latter themselves into the repent amœboid bodies, putting a parasitic development wholly out of the question ; it will readily be believed, I say, that my astonishment was beyond measure great, in actually witnessing with my own eyes this, at first sight, sufficiently startling phenomenon." *

But observations of this kind have not been confined to Algæ. Hartig, in 1856, watched the development of Amæboid forms from *Chara* and *Polytrichum* ("Quart. Journ. Micr. Sci.," 1856, p. 51), and in the *Amœbæ* of the *Characeæ* he observed a remarkable circulation similar to that which occurs in the cells of *Chara*. We can hardly be surprised that above a quarter of a century ago he

* "Quart. Journ. Micr. Sci.," 1865, p. 125.

was led to ask, "Does *Amœba* belong to the animal kingdom, or is it a stage of vegetable development?"

Finally, Dr. Hicks traced the progress of similar forms from the radicles of mosses kept in water ("Quart. Journ. Micr. Sci.," 1862, p. 97). "I arrived at the fact," he says, "that the endoplast of many of the elongated cells not unfrequently detached itself from the contact of the cell wall, and collected into one or more ovoid masses of different sizes." After describing other changes, he thus proceeds—"they gradually began to alter their form, and to protrude and retract processes, exactly as *Amœbæ*, and as was noticed in the *Volvox*. They travelled up and down the interior of the cells, occasionally elongating themselves into almost a linear form."

There is evidence then, that movable living Protean bodies, resembling *Amœba* have been found developed from *Myxomycetes*, *Chlamydococcus*, *Volvox*, *Stephanosphæra*, *Chara*, and Mosses; forms not to be distinguished from *Amœba*, except by their origin. It may be assumed that no one here present will contend that a true animal *Amœba* may have a vegetable parent, but, on the contrary, they will have arrived at the conclusion that there is a closer and more intimate relation between the phenomena of life in plants and animals than we have hitherto been willing to assign.

It is scarcely necessary in a Society of this kind to remind you of the existence of zoospores in the regular course of development of many Algæ, and Fungi. These small unicellular bodies, furnished with vibratile cilia, move about actively in fluids after the manner of infusoria. At first, when their existence was demonstrated, it was contended that they were infusoria developed in the interior of growing plants, and yet it has since been established that they are not animal at all, but simply active spores, which soon become quiescent, germinate, and produce veritable plants like their parent. Not only are they almost universal in Algæ, both marine and fresh water, but in such Fungi as the *Saprolegnia* of the salmon disease, and its allies; and in the species of *Peronospora* and *Cystopus* they perform an important part in the reproduction of the species. As there was an analogy between the amœboid forms of the *Volvocineæ* and the animal *Amœbæ*, so here in the zoospores of cellular cryptogams we encounter organisms analogous to Infusoria.

In passing, we may refer to the memoir by Professor Meneghini, translated and published by the Ray Society in 1853, entitled, "On

the Animal Nature of Diatomeæ," which comes to this at last—"I conclude, however, that in the actual state of science, the Diatomeæ are to be enumerated among animals, but at the same time much remains to be accomplished in order to disclose their intimate organization and vital phenomena."

Haeckel proposes, in his "History of Creation" (ii., 48) to place eight of the simplest groups of living creatures in a separate kingdom intermediate between the animal and vegetable, under the name of *Protista.* These are *Monera*, the *Amœboidea*, the *Flagellata*, the *Catallacta*, the *Labyrinthuleæ*, the *Diatomeæ*, the *Myxomycetes*, and the *Rhizopoda.* This is a poor method of getting out of a difficulty, and one which I think will only be accepted as a temporary and provisional expedient. Afterwards he hints at *Monera* as merely a simpler form of *Amœbæ*, and the latter of *Rhizopoda*, so that through the last named they are linked to the animal kingdom. The affinities of the Myxomycetes are undoubtedly with Gasteromycetous Fungi, and the *Diatomeæ* with conjugating Algæ. Hence the bulk of *Protista* find their relationships in the vegetable and animal kingdoms respectively. Because no logical definition, which is indisputable, has been found to mark the limits between the two kingdoms, is no reason for cutting the "inextricable knot" so rashly. Time and patience may reveal the affinities of all the "doubtful beings" which he has determined to "exclude from the animal as well as from the vegetable kingdom, and to comprise them in a third organic kingdom standing midway between the two others." Or perhaps this may be an obscure way of hinting that organic life is the same whether in plant or animal, and that all were linked by the Protista in one homogeneous whole, which ultimately divided into two branches having their origin in one trunk. At least his view strengthens the position assumed in this Address.

Ehrenberg included amongst his Polygastric Infusoria the *Closterina*, *Bacillaria*, and *Volvocina*; that is to say the *Desmidiaceæ*, the *Diatomaceæ*, and the *Volvocinæ.* Siebold found it necessary to combat this arrangement little more than thirty years ago.* Amongst other suggestions he says that "we can scarcely expect chemistry to decide what is animal and what plant, having several times been deceived in our hopes in this respect. The non-

* Siebold and Kolliker, "Leitschr. fur Wiss. Zool.," i., p. 270. "Quart. Journ. Micr. Sci.," 1853, pp. 111-159.

nitrogenous cellulose, which at first sight appears to be an exclusive attribute of the vegetable, also occurs pretty generally disseminated in the animal kingdom, as we learn from the researches of C. Schmidt on *Cynthia mamillaris*, and those of Kolliker and Löwig on a great number of the most various of lower animals. Just as little does Chlorophyll appear to be exclusively characteristic of the vegetable world, since the green granules and vesicles, which occur imbedded in the parenchyma of *Hydra viridis*, of various *Turbellariæ*, and of Infusoria are probably closely allied to Chlorophyll, if not identical with it. Erythrophyll also might be said to occur in the lower animals, for instance, in *Leucophrys sanguinea* and *Astasia hæmatodes*, in which latter the red colour frequently passes into green, as does the erythrophyll of unicellular Algæ."

Nægeli * was the first to point out that in many of the unicellular Algæ red spots occurred which in all respects were identical with the "red eye spots" of certain of Ehrenberg's Infusoria. These spots occur, not only in *Polyedrium*, but also in *Eudorina*, *Chlamidomonas*, and other *Volvocineæ*, as well as in the swarm spores of *Hormiscia*, or *Ulothrix*, and some other genera. Siebold says, " How strikingly the swarm spores, both of unicellular and of multicellular Algæ resemble certain *Monadina* and *Cryptomonadina* is well seen in the representations of various spores of this kind, given by Unger, Thuret, Solier, and Nægeli."† His remarks conclude with this significant paragraph. " From this report on the more recent labours of botanists in the field of the lower vegetable world it may be seen how important and indispensable the study of this branch of botanical knowledge must be for those who would successfully apply themselves to researches connected with the lower animal kingdom."

* Nægeli, " Gattungen einzelliger Algen," 1849.

† " It is well known that Unger discovered that the motion of the spores in *Vaucheria clavata* was effected by a general ciliary investiture, a discovery which was confirmed by Thuret. The same observer noticed a circlet of cilia in the swarm spores of *Œdogonium*, as did Solier in *Bryopsis*. According to Thuret, the zoospores of *Cladophora glomerata* swim about with the aid of two lash-like cilia, and those of *Chætophora elegans*, on the other hand, with four. Nægeli figures the zoospores of *Apiocystis*, *Tetraspora*, and *Characium* with two such cilia. Fresenius detected in the biciliated zoospores of *Chætophora elegans*, also the (so-termed) red "eye-spot." According to the researches of Braun, a formation of spores occurs in *Hydrodictyon*, in consequence of which zoospores, with four long cilia and a red granule in the interior, swim about with great activity."—Siebold, *loc. cit.*

The phenomena of reproduction in animals and plants present many features worthy of comparison. It is scarcely rash to say that sexuality is as common and universal in the vegetable as in the animal kingdom. Not many years ago such an assertion could scarcely have been ventured upon with confidence, when the reproduction of the lower cryptogamia was so little known, but every new discovery adds strength to a belief in universal sexuality. The completeness of the sexual organs and their functions is not a matter of mere speculation. The male and female organs are definite and distinct. They approach each other, as it were, instinctively, and unite. The ovary receives the contents of the antheridium, which, in many cases, are multitudinous active spermatozoa, with a remarkable similarity to the same bodies high up in the zoological scale. The opening of the ovary just as the spermatozoids are matured, as in the genera *Œdogonium* and *Vaucheria*, the entrance of these and their absorption, and finally the maturing of the fertilized ovum, are notable analogies. If we seek more special and particular examples these can be found. What, for instance, could be more suggestive of the fusion which takes place in some of the Infusoria, in which two individuals meet, collide, and finally coalesce in one individual, than the conjugating zoospores in *Botrydium granulatum*, where two active zoospores unite, and by their union become a true fertilized isospore, in which all motion soon comes to an end, and is followed by the development of a young plant like its original parent. These are some of the phenomena which startled certain of our progenitors into the supposition that infusoria were generated within, and ultimately escaped from, the tissues of living plants.

Metamorphosis, such as we are acquainted with in insects, has also its analogue in the vegetable kingdom. From the egg of a butterfly emerges, not a form like the parent, but a caterpillar, which passes through a period of existence and then comes to rest ; it changes into a pupa or resting condition, in which it remains for a more or less lengthened period, then its final change takes place, and the perfect imago appears, the true image of the original parent. In some of the lower plants we may recognise a similar metamorphosis. In some of the Myxogasters, for instance, the spore, which is the ovum or egg, produces a larval form, an active zoospore. After a time this becomes amœboid, more sluggish, and quite different from either zoospore or parent, and finally from the

amœboid form results the perfect imago, or image of the plant from which originally the ovum was derived.* If exception should be taken to any of the Myxogasters being employed in illustration, inasmuch as their vegetable nature has been called in question, then we can fall back on the life history of *Volvox globator*, *Stephanosphæra*, and other of the *Volvocineæ*, to say nothing of mosses and *Characeæ*, already alluded to, which furnish less perfect transformations. Although not conducted on so large a scale as in the animal kingdom, it is clear that we have at least suggestions of metamorphosis also in the vegetable world.

Alternation of generations, as applied zoologically, differs materially from metamorphosis, although they are sometimes confounded as though they were convertible terms. The fundamental idea is that of an organism "producing an offspring which at no time resembles its parent, but which, on the other hand, itself brings forth a progeny which returns, in its form and nature, to the parent animal, so that the material organism does not meet with its resemblance in its own brood, but in the descendants of the second, third, or fourth degree or generation, and this always takes place in the different animals which exhibit the phenomenon in a determinate generation, or with the intervention of a determinate number of generations."† The characteristic difference between this and a simple metamorphosis is that each generation completes its career in the same form as it commenced, so that each starts from an ovum, and the cycle is *not* the career of a single individual, but of a consecutive series of individuals, which revert to the original form after one, two, or more intermediate and differing generations.

In Ferns an alternation of generations is evident. The fronds of mature ferns bear on their under surface, or margin, clusters of spore-cases containing minute spores, which themselves are produced

* When placed in water the membrane of the spore opens, and its contents escape in the form of a cell clothed only by a very thin primordial utricle. These escaped cells undergo changes of form, eventually exhibiting one or two cilia. They have also a motion of progression and rotation, as in the case of ordinary zoospores. After a few days bodies appear precisely as in the *amœbæ*, like which they have a creeping motion, and are perpetually changing their form. These are produced from the zoospores. From these again the author proceeds to show the complete form of the Myxogaster is developed, concluding, "direct development of the fructifying threads from the *Amœbæ*, produced by the growth of the zoospores, appears to me beyond a doubt." See "Quart. Journ. Micr. Science," 1860, p. 100.

† Steenstrup, "Alternation of generations," Ray. Society, p. 1.

without sexual fertilization. These spores germinate and produce a little plant called a prothallium, not at all like the parent fern, but a small simple plant nourished by root-hairs. This prothallium is capable of repeating itself by buds, but finally it produces male and female organs, and the result of fertilization is a true embryo, sexually produced, which develops into a Fern, like its asexual parent. Thus there is an alternate asexual and sexual generation, the sexual being the small prothallium, and the asexual that more imposing form which we are in the habit of calling a Fern.

In Mosses a somewhat similar alternation prevails. The germinating spore produces a confervoid thallus called a *Protonema,* from this the leafy moss is developed by buds on the branches. Sexual organs are formed, and finally, after fertilization, spores are produced.

It is unnecessary to repeat instances, since my object is more suggestive than exhaustive, and in fact the subject could not possibly be extended in all its details within the narrow limit of time at my disposal. Fanciful analogies have been propounded by some botanists, to which allusion is made in Sachs' "Text Book" (p. 228); but it is unnecessary to refer to them further. Some also claim for the *Æcidiomycetes* a true alternation of generations, but the continuity is not sufficiently established, with alternate reversion to an embryonic condition, to warrant acceptance as a morphological fact.*

"Parthenogenesis is the term used to express the fact that plants (or animals) which possess normal male organs of fertilization, and in which embryos are developed by the fertilzation of the oospheres may occasionally develop embryos from female cells which have not been fertilized, but which are nevertheless capable of complete development." † This is not an uncommon phenomenon in the animal kingdom, but is comparatively rare in plants. It was supposed at one time that *Cœlebogyne ilicifolia* ‡ presented a clear case of parthenogenesis, but recent researches have thrown doubt upon it, inasmuch as the phenomena seem rather to be attributable to a kind

* Leuckart, who began by separating parthenogenesis from alternate generation, saw an essential difference between the two phenomena, viz., that in the first fecundation *may* occur before every reproductive act, but that in the second it *must* occur from time to time in certain fixed acts of reproduction. "Biblioth. Univ. de Geneve," 1859.

† Sachs' "Text Book of Botany," Ed. ii., p. 902.

‡ J. Smith, "Linnean Transactions," xviii., p. 509.

of budding, or geneagenesis, than to true parthenogenesis.* From the researches of Pringsheim and De Bary, nevertheless, we are justified in still holding parthenogenesis to be a phenomenon exhibited in plant-life as well as in animal, for the disease of salmon (*Saprolegnia ferax*) and most of its allies present parthenogenetic forms. Pringsheim states distinctly that "the successive generations both of *Saprolegnia ferax* and *Achlya polyandra*, produced by cultivation, become smaller, and the number of male filaments diminishes in each succeeding generation until they finally cease to be formed, and thus the monœcious forms become replaced by purely female ones," which shows that under cultivation the formation of male organs diminishes and ultimately ceases, and then parthenogenesis comes into operation. *Chara crinita* is represented in some localities by the female form only, yet bears an enormous number of spores capable of germination.†

Germination, or increase by budding, is such a common phenomenon in plants that it is scarcely necessary to allude to it; the same process in animals being much more rare. A familiar example may be found in the common Hydra. Quatrefages says, "I agree with Owen, Steenstrup, Van Beneden, Carus, &c., in considering the agamic reproduction of aphis to be due to a process of internal budding. It has been proved by the researches of these naturalists that the reproductive bodies which are developed during summer in the wingless aphides are simple deciduous buds."‡ And again the same author, "There is but *one* mode of sexual reproduction, whilst there are several forms of agamic generation which are found equally in the two kingdoms. In certain plants we find, besides the true bud—the bulb—a genuine bud, like that we have referred to, but which becomes detached from the parents, and is developed by itself as though it had been a seed. We ourselves have found this deciduous bud in *Synhydra*, an animal closely akin to *Coryne*. The lower Algæ are propagated by spontaneous division, and the infusoria are in no way behind them in this respect. Trembley propagated Hydra by artificial cuttings, perhaps more extensively than

* Strassburger, "Polyembryonie," Jena, 1878. In this connection may also be consulted "Farlow on Pteris cretica," in "Quart. Journn. Micro. Sci.," xiv. (1874), p. 267.

† Sachs' "Text Book," p. 902. See also on Parthenogenesis, Siebold on True Parthenogenesis in Moths and Bees, translated by W. S. Dallas. Prof. Owen on Parthenogenesis, Braun Uber Parthenogenesis bei Pflanzen, Berlin, 1857.

‡ "Metamorphoses," p. 168, note.

any gardener ever propagated a plant by the same means."* Strassburger attributes the supposed parthenogenesis of *Cœlebogyne* to a process of budding.

A quarter of a century ago it would have appeared absurd to speak of plants without stomach digesting and assimilating animal food, and yet, strange as it would then have seemed, it has now come to be recognised that there are carnivorous plants, undoubted plants, which catch insects, dissolve and digest them, just as animals would do. Dr. Burdon Sanderson, after describing digestion in animals, says :—" Between this process and the digestion of the Dionæa leaf the resemblance is complete. It digests exactly the same substances in exactly the same way, *i.e.*, it digests the albuminous constituents of the bodies of animals just as we digest them."† Again he says—" When we call this process digestion we have a definite meaning. We mean that it is of the same nature as that by which we ourselves and the higher animals in general convert the food they have swallowed into a form and condition suitable to be absorbed, and thus available for the maintenance of bodily life." A summary of the investigations in this direction has been given in a work ‡ accessible to all, from which it is evident that there is a striking analogy between the operations performed by fly-catching plants, such as the Sun-dews and the Fly-trap, and the process of digestion as known in the animal world. Mr. Darwin has given details of a number of experiments in this direction in his volume on " Insectivorous Plants," and no one has called either the facts or the inferences into question.

Although in plants we have no nervous system, and consequently no sensibility, we encounter phenomena which simulate in an extraordinary manner the manifestations of sensibility in the animal world. The clasping of the tentacles in *Drosera*, the closing of the leaves in the Fly-trap, the movements in the leaves and leaf-stalks of those called " sensitive plants." There is an apparent sensibility to external impressions, and there is also the power of transmitting impressions from one part of the plant to the other.§ The coincidence of the effects produced on animals and certain plants by electricity, as demonstrated by M. Blondeau, the observations of Dr. Masters on the influence of the ether-spray on plants—

* " Metamorphoses," p. 270.

† " Gardeners' Chronicle," June 27, 1874.

‡ " Freaks and Marvels of Plant-life," p. 38, &c.

§ *Ib.*, p. 226.

all these instances must be accepted as remarkable analogies to sensibility as exhibited in the animal world; and, in a smaller degree, the same may be said of the movements of the stamens in some flowering plants, the irritability of the labellum in orchids,* and even to those movements under the influence of light which are known as "heliotropism," "dia-heliotropism," and "nyctitropism." "Why a touch," writes Mr. Darwin, "slight pressure, or any other irritant, such as electricity, heat, or the absorption of animal matter, should modify the turgescence of the affected cells in such a manner as to cause movement we do not know. But a touch acts in this manner so often, and on such widely different plants, that the tendency seems to be a very general one, and, if beneficial, it might be increased to any extent."†

Neither can we find in plants any such high development of what is termed instinct as manifested in birds, dogs, horses, and other animals, but there would seem to be faint indications of similar tendencies even amongst plants, otherwise how is it that in such Algæ as *Œdogonium* certain privileged cells produce spermato zoids, which, though limited in number, find out the small opening in the distant female cell, and straightway enter it and perform the act of fecundation? or in such other species as produce in cells of a distinct and different filament, or plant, the active fertilizing agents? Or, again, in those species which produce active infusoria-like bodies from certain cells at some distance from the female cells, and yet these bodies find their way not only to the cell, but, according to the species, attach themselves either to the outside of the female cell or to the cell which supports it, then elongate, and develop into pigmy male plants, in time producing their own spermatozoids, which enter and fertilize the ovum contained in the female cell, near or upon which they are located. Why do they select a particular place, a particular cell, to which to attach themselves, so that when the spermatozoids are developed they are close to the orifice, which it is essential for them to enter if the oospore is to be fertilized? This is only one instance, but others could be alluded to if time permitted.‡

* Darwin, "Fertilization of Orchids," p. 172.

† "Movements of Plants," p. 571.

‡ Not to mention the problematical case of the spores of the Berberry fungus travelling twenty miles, or even across the sea, in order to produce mildew in wheat, which some mycologists seriously believe, or fancy that they believe, although without analogy in the animal world.

Mr. Romanes, in his volume on "Animal Intelligence," claims for the lowest forms some amount of intelligence.* If true of the Amœba and of Infusoria, like phenomena being exhibited in certain Algæ, may it not be true of them also?

The only remaining aspect of this subject to which I will now briefly allude is the analogy between the diseases of plants and animals. The importance, as well as the usefulness, of studying the manifestations of disease in both kingdoms was strongly urged by Sir James Paget in his address at the British Medical Association in 1880.† It is not my intention to follow him through this Address, which abounds with useful and apposite suggestions, but to pick up a paragraph or two here and there to exhibit its features. "I have long and often felt," he says, "that we might gain help from studying the consequences of injury and disease in the structures of plants;" and again: "I have seen enough to make me more than ever sure that human pathologists may find, in watching the consequences of injuries and diseases of plants, facts of the highest interest in their more proper study."

And first of hypertrophy. "There are in plants," he says, "abundant opportunities of studying those forms of hypertrophy which depend on an increased supply of nutritive material to any part. To mention but one: the arts of partial or complete 'ringing' and of constricting or bending the branches of trees depend for success on their insuring an accumulation of nutritive sap in the part of the branch from which its movement is checked. The result is what we may call an hypertrophy of flowers, or, in other instances, of fruit, or wood, or bark, proportionate to the increased supply of nutriment, just as, in ourselves, hairs and some other structures will grow excessively with an excessive efflux of blood; or, still more, and in almost exact parallel, as limbs will grow with a retarded reflux of lymph." He then proceeds to illustrate compensatory hypertrophy with some examples,

* "No one can have watched the movements of certain infusoria without feeling it difficult to believe that these little animals are not actuated by some amount of intelligence. Even if the manner in which they avoid collisions be attributed entirely to repulsions set up in the currents which by their movements they create, any such mechanical explanation certainly cannot apply to the small creatures seeking one another for the purposes of prey, reproduction, or, as it sometimes seems, of mere sport."—"Romanes, Animal Intelligence."

† "An Address on Elemental Pathology," by Sir James Paget.—"British Medical Journal," Oct. 16 and 23, 1880.

and passes on to atrophy, selecting for "atrophy with degeneration" the fall of the leaf. Here is interpolated a note on liquefactive degeneration, diseases associated with degeneration. "Such," he says, "are the gum disease (gummosis), the resin-flux (resinosis), and others of the same group, which I find classed as liquefactive diseases, and in which cell-walls, wood, and other structures dissolve in, or into morbid products. I venture to guess that these may give help in the study of our mucoid and other liquefactive degenerations."

Passing over many curious analogies, we encounter a contrast, with a subsidiary analogy, in "repair of injuries." "Let me," he says, "relate one case. A fir tree, fifty years old, had a large piece of bark stripped from its trunk. The wound extended round nearly a fourth of the circumference of the trunk, and laid bare the wood. It was not dressed or guarded; the outer layer of the exposed wood died as usual, and then every year the successive annular growths of new wood and bark extended a little further over the bared place. In one hundred and fifty years these growths met and coalesced, and the wound was covered in. When the tree was felled and cut through at the injured part, where there was still a deeply-depressed scar, the concentric rings of wood proved the growth of fifty years before and one hundred and fifty after the injury, and even now the healing was not complete; there was still a cavity between the old wood and the new; the healing was not such as we should call good in any similar case in an animal. Still, there was healing; the 'intention' was maintained for a century and a half."

From the processes of repair Sir James passes to inflammation. "The likenesses between the inflammations in plants and in animals are best shown in their visible structural changes, and these have been admirably traced by Waldenburg. He has applied various irritants to leaves, fruits, and stems, such as foreign bodies, setons, crushings, cauteries, and others. The results, speaking very generally, are that, as in ordinary wounds, the cell structures actually involved in the injury perish aud dry up; that those most nearly adjacent suffer degeneration, indicated by their protoplasmic contents becoming turbid and their chlorophyll becoming yellowish or brownish, while in those next to them, and within distances varying according to the injury and the texture of the part injured, enlargement of cells ensues, and increase by division and thickening of the cell-walls. In these changes you may study, with compara-

tively easy experiments, imitations (as near as differences of texture will allow) of the most constant constituents of inflammation in animals, especially those of the least acute of the productive interstitial inflammations, leading to thickening, opacity, induration, and other such changes."

The succeeding remarks on galls and their analogues cannot be abstracted, but should be read *in extenso.* "There are," he says, "reasons enough for regarding all these galls and gall-like products of disease, generated in plants by insects, as analogous with a large group of the products of inflammation, which we study in our own pathology, and the analogy is not the less because neither group can be circumscribed with any exact definition." Of tumours he says—"The growths in plants which may, I think, be deemed most nearly like to our tumours, are those which are called exostoses, knours, or wens. In many of these conditions there is a very strong resemblance between these growths and some of the bony exostoses after which they are named. Especially when one breaks them off the trunk of the beech, or the holly, or cedar, and sees their pedicle of attachment and the bark-like integument and periosteum, continued over them, one cannot but compare them with the narrow-based ivory exostoses of the skull or the pedicled exostoses which are common on the femur and humerus, or with the sessile fibroid uterine tumours."

And again, "Now the history of these growths is very suggestive to us. They are derived from buds, which remain, as Trecul says, in a sort of lethargic state for several years, and then become active, and form either a little branch, or a loupe, or exostosis, which in its increase will project more and more beneath the bark. Surely they may thus confirm that theory of tumours, which regards those whose structure does not widely differ from the natural structures, as growths derived from portions of germinal substance remaining, though one knows not why, for years 'lethargic' and then becoming active, growing in their own method, and subsisting on materials derived from the living parts around them."

The whole of the address from whence the above scattered extracts are derived is well worthy of careful perusal by those interested in tracing the resemblances between the diseases of plants and animals. But we must pass on hurriedly to some other relationships between the phenomena of disease in plants and animals not included in the address to which we have alluded.

No one would attempt to deny the hereditary transmission of

diseases in plants, as well as in animals, although sometimes it would seem that theorists entirely forget the circumstance, or practically ignore it. The twelfth chapter of Darwin's "Variation of Animals and Plants Under Domestication" seems for the time to be forgotten. Whilst inheritance of insanity, gout, epilepsy, consumption, asthma, cancer, &c., are admitted in the human subject, and other diseases in lower animals, insufficient importance is attached to the same tendency in plants. It must now be tolerably clear to most minds that something of the potato disease, the hollyhock disease, and even the wheat-mildew, will be due to inheritance. It would be folly to deny such a probability. The fact has been before quoted that celery plants, raised from the seed of plants greatly infected with the celery disease (*Puccinia apii*) were similarly infected though growing in the same garden, at a few yards distance from perfectly clean plants grown from the seed of uninfected parents. Instead, however, of permitting themselves to think of hereditary transmission, some authors have indulged in fanciful speculations as to the inoculation of plants with certain diseases, as if they had no parents with diseases to transmit, or were wholly incapable of transmitting them. In the face of the marvellous changes which the Florist and Pomologist has produced in our cultivated flowers and fruits by taking advantage of this very powerful tendency of inheritance, it is passing strange that any should ignore such agency for a remote speculation, which has no equivalent support from experience or analogy.

The Rev. M. J. Berkeley has thus written :—

"There is something extremely capricious in the attacks of these diseases amongst plants, exactly as is the case with infectious maladies amongst ourselves. One is taken and another left without our being able to account for it, nor is it probable that we shall ever penetrate these mysteries, which baffle all our efforts, and remind us of our true position in the scale of intelligent beings.

"A perennial plant or tree once attacked by parasites seldom gets perfectly free from the disease, and there may be a greater analogy in the peculiar liability of certain constitutions to the recurrence of such maladies as influenza, to the fact that in the present state of our knowledge as to the cause of disease we should at present be willing to allow. A plant of *Achillæa ptarmica* was given to us at Lille, in the month of March for the express purpose of bearing a crop of *Labrella Ptarmicæ* the ensuing autumn, which it

did not fail to do, though the fungus is at present not known as indigenous to this country.

"The subject has, however, been recently called more forcibly to our notice from some remarkable phenomena which have occurred in a garden near London, where all the plants of *Pyracantha* arising from particular seed are more or less completely destroyed by the same species of *Cladosporium* which has injured the pear trees. The plants were raised from Russian seeds, about four or five years since. They first appeared to be blighted last year, but inconsiderably. This year they are nearly all killed. The old shoots are black with the spores, the leaves crumpled and withered; and the late shoots and leaves now forming are about to break out as their predecessors. The seedling bushes are in heavy land well drained, but the disease is confined to them; old bushes of *Pyracantha* in the same places are perfectly clear."*

It may be asked if any of the diseases of plants are infectious in the same manner as small-pox or foot-and-mouth disease. Undoubtedly this may be answered in the affirmative, as the potato disease, the hollyhock disease, the coffee leaf disease, and the vine mildew would prove. They may be disseminated by inoculation, and there is no reason why some of them may not be mitigated by some process analogous to vaccination. The larch disease extends over large tracts, but it cannot be placed in the same category. Willkomm endeavoured to show that the larch disease was produced by a *Peziza*, but I think that he has failed to establish it, both by fact and analogy, for it appears to be traceable rather to resinosis, of which the fungus is only an adjunct, growing upon the diseased tissue, and that resinosis, like gummosis, is not infectious.

It cannot be a trifling circumstance that the invasion of our island by all the principal epidemics affecting plants, have coincided remarkably with the epidemics affecting animals. The hollyhock disease (*Puccinia malvacearum*) first known in South America, travelled to Australia into Europe, and at length made its appearance on the coast of England, on the continental side, travelling gradually onwards until it covered the entire country, in successive waves, just as cholera or cattle disease would do if left to themselves, and as the potato disease had done before.† It may be only

* M. J. B., "Gard. Chron.," Oct. 28, 1848, p. 716.

† The potato disease appears to have been observed in Belgium in 1842, according to Morren, and about the same time it was stated to have been

a fanciful analogy, but it seems to me that there are striking coincidences in the advent and spread of these contagious diseases, whether affecting animals or plants. Even in some of the minor details affecting the dispersion of the disease the analogy is continued. We seem to be reading, between the lines, of some malignant fever, or of some animal contagion, when we read of the conditions favourable to, or opposed to the spread of plant epidemics.*

Alluding to the hollyhock disease, a writer says ("Gard. Chron.," Aug. 22nd, 1874, p. 243), "I believe planting the hollyhock in large crowded beds should be avoided, as I have observed the closer they are growing the more virulently does the disease attack them, whereas isolated rows and plants are but little injured."

The Inspectors of Fisheries, in their Report (1880, p. 19.), quote the following evidence given before them :—"The river is overstocked, so is every river where there is a fungus. It is a symptom of overstocking. Rivers will only carry a certain amount of fish ; when you get beyond this, the disease appears." In addition to evidence the following opinion is expressed by the Inspectors themselves (p. 20.) :—"In confirmation of the fact that overcrowding of fish will produce fungus growth, it is important to note that (as all breeders of salmon by artificial means know only too well) when the young of *Salmonidæ* have attained a certain growth if they are too crowded in the hatching trough, they at first breathe with great difficulty, and ultimately die with the gills propped widely open by a growth of fungus. If the fish are allowed to remain in the water in a few hours the fungus will spread completely over the whole of the body, growing equally from all parts of the body, so that finally it assumes the appearance of thistle-down."

observed in Ireland ("Gardeners' Chronicle," 1845, p. 674), but the great outbreak was in 1844 and succeeding years. It was known in Canada and some of the United States in 1844, in Saint Helena in the same year, and then first appeared in the Isle of Thanet (Berkeley in "Hort. Journ.", i., p. 12). In 1845, on the 16th August, it was seen in the Isle of Wight; on the 23rd August in the south of England generally ; but up to the 30th was still unknown in the Midland counties. By the 7th September it had shown itself in Ireland, and later in the year in Scotland. The history of its early progress is recorded by Rev. M. J. Berkeley "On Potato Murrain," in "Journ. of Royal Hort. Society," Vol. i. for 1846.

* "When the array of diseases produced by fungi, which, formerly unnoticed, have, in later times, attracted universal attention by their destructive consequences, is surveyed, it might readily be supposed that, as in the diseases to which the human frame is subject, every period has its prevailing character, so also, in the vegetable kingdom, certain variable and secular influences prevail, to which is to be ascribed the circumstance of the present activity of diseases produced by fungi."—Braun, "On Diseases of Plants," "Quart. Micro. Journ.," 1854, p. 253.

It remains for me only to indicate what bearing I consider the observations I have made to have on us and our work. What is the practical conclusion to which we are led, by assuming such a close relationship between the manifestations of life in plants and animals, such an analogy, if not identity, of phenomena? In the first place I consider that it justifies the union of all biologists, as in this and similar associations, in one and the same society. It is well enough, for purely classificatory purposes, that ornithologists, lepidopterists, bryologists, fungologists, and other specialists, should have their associations. There are facts of distribution, variation, &c., in which they alone are particularly interested, to be recorded, but outside the limited interest in an organism which is bounded by its specific name, there are larger and more universal interests which do not belong to the specialist alone, but is the common property of all biologists, and which they should be made to feel and share. In associations which for any purpose unite all sections of biologists, their justification may be read in our suggestions.

In the next place, it is more than justified, it is shown to be absolutely essential for their success that co-operation should be maintained between zoologists and botanists. It is not enough for the botanist that he should be acquainted with flowering plants alone, he should also know something of the life-history of the lower vegetable organisms, even down to a single cell. Nor can he stop here, for if he would rightly comprehend the metamorphoses, the alternation of generations, the different phases which he encounters, he must have some knowledge of the same phenomena as exhibited in the animal world. It may not be necessary that he should follow the example of Adam, and give to every animal a name, but he should know something of its career between its ovum and final act of sexual reproduction. Human life is too short and exacting to permit of a close pursuit simultaneously of all branches of biological science, but the facts gleaned by mutual intercourse may be gathered without effort, and no item of experience so obtained will be barren in the future. No discovery in the life history of animals is, or ought to be, devoid of interest to the botanist, as no investigation in the phenomena of life in plants can be ignored by the zoologist. The earnest worker knows well enough in whichever field his operations may be made, what a flood of light may illume his work which proceeds from the other side.

Thirdly, if it be true that there is so great an analogy between the phenomena of life in both worlds, this should lead to a greater

sympathy amongst all who call themselves "students and lovers of nature." It is but a small intellectual life that is bounded by a diatom or a bug, and the mental activity which expends itself in counting striæ, or the joints of antennæ, will scarcely aspire to more. Verily, they have their reward. But many there be who go beyond this, and would interrogate at every step, wherefore this? and wherefore that? and to these I would say, step out of your own field, and walk in your neighbour's garden, and scent the odour of *his* flowers, and you will learn how much such exercise will help you to enjoy your own. There are some who do not care to read a book, hear a lecture, or converse with a stranger on any but their own hobby. Their sympathies are too narrow, and the best method of expanding them is to join fellowship with a society which embraces all biological subjects, then to interest himself in everyone's subject, except his own, and a few months will prove, not only how much he has gained in general biological knowledge, but, more than this, how much more readily and satisfactorily he can perform his own work by the light which he has borrowed from others.

Lastly, and this is of wider application than to ourselves, such a view as I have urged might well furnish a test for crude theories, of which many have been born and died during the past thirty or forty years. When such a theory is presented to us, it is well to inquire how it accords with our own experience and that of others, not only in vegetable but animal life. To ask is there any biological analogy for such a theory? are there any biological facts to support it? If not, then it must be the more carefully examined, for it comes ushered in by a doubt. For example, if we are asked to believe that lichens are only a combination of Fungi and Algæ, we may be led to inquire whether Batrachians, which on one hand may resemble fish, and on the other mammals, are, in fact, only a combination of fish and mammal. If such be really the case, some analogy may be predicated between Lichens and Batrachians.

The remarks which I now draw to a close are far from exhaustive. The subject could not be exhausted so readily. I have not entered into minute details and examples for which no time was at my disposal. I do not pretend to have done more than introduce you to a subject of interest worthy of contemplation, and have scattered a few suggestions by the way. I leave to each the task of filling up, and covering, my skeleton with muscle and skin according to his predilection. If there is a good foundation for the

assumption that life is pretty much the same in plants and in animals, that they originate in the same manner, that they pass through similar gradations, are subject to like diseases, and finally deposit the germs of a new generation and die, then not only is the study of one a help to the other, but a knowledge of either is essential to the accurate appreciation of the other. In its higher aspects we are led to contemplate the unity and harmony of the organic world, that through Nature we may look up to Nature's God

> And to the beautiful order of *His* works
> Learn to conform the order of our lives.

REPORT OF THE COMMITTEE.

July 27, 1883.

Your Committee, in presenting the Eighteenth Annual Report, are glad to notice a marked increase in the vitality of the Club during the past year.

The number of our members continues nearly the same as last year, our losses by death having been six, viz.—Colonel Basevi, Mr. W. A. Delferier, Mr. Robert Hudson, the Hon. Sackville F. H. Lane-Fox, Mr. W. Rawles, and Mr. F. Wood. None of these members took any very active part in the affairs of the Club, though two of them were well known in connection with some other Scientific Societies. Twelve members have resigned, nineteen have been struck off for non-payment of their subscription for several years, and *thirty-three* new members have been elected. Our members are, therefore, slightly reduced, but with no serious loss to the efficiency of the Club.

The following is a list of the principal communications made at our meetings :—

1882.

Aug. 25. "On the estimation of the numbers of Foraminifera found in Chalk," by the President.

Sept. 22. "On a quick-acting Nose-Piece," by Mr. E. M. Nelson.

"On Professor Abbe's method of testing Microscopical Objectives," by Dr. C. Zeiss.

"On Dr. Heneage Gibbe's method of preparing *Bacillus tuberculosus*," by Mr. G. C. Karop.

Oct. 27. "On the fibro-vascular bundles in Ferns, and their value in determining generic affinities," by Mr. T. W. Morris.

Nov. 24. "On the Statoblasts of the Fresh Water Sponges," by Mr. B. W. Priest.

"On Diatomacearum Dillwynii," by F. Kitton.

"Some Remarks on Mr. Hensoldt's paper on Fluid Cavities in Meteorites," by Mr. A. de Souza Guimaraens.

Nov. 24. "Further remarks on Fluid Cavities in Meteorites," by Mr. H. Hensoldt.

Dec. 22. "On Mounting in Glycerine," and "Making Cells of Thin Glass," by Dr. H. T. Whittell.

1883.

Jan. 26. "On a New Form of Fructification in *Vaucheria*," by the President.

Feb. 23. "On an Undescribed Sponge of the Genus *Hymeraphia*," by Mr. J. G. Waller.

April 27. "Notes of the Excursion to Regent's Park and Caen Wood," by the President.

"On Preparing Insects for Transmission from Abroad," by Mr. Staniforth Green, of Ceylon.

May. 25. "Notes on the Excursion to Keston," by the President.

"On the Causes of some Errors in the Interpretation of small Microscopical Objects," by Mr. E. M. Nelson.

June 22. "On the Work accomplished by the United States Coast Survey and the Fish Commission," by Mr. Romyn Hitchcock, of New York.

In addition to these, the short communications have been more than usually numerous and interesting, consisting principally of descriptions of objects or apparatus exhibited, showing evidences of good work, and offering opportunities for useful discussion. We must still, however, regret the deficiency of more important papers, which now mostly find their way to the larger Scientific Societies.

Six elementary demonstrations on subjects connected with microscopy have been given on the Conversational Evenings, and, with one exception, were held in a class room, in order to avoid any interference with the social intercourse of those meetings. The following is a list of these Demonstrations :—

1882.

Dec. 8. "The History of a Stained Section of an Animal Structure," by Mr. J. W. Groves.

1883.

Jan. 12. "Photo-micrography," by Mr. T. Charters White.

Feb. 9. "Sea-side Collecting," by Mr. A. D. Michael.

Mar. 9. "Some methods of preparing parts of Insects for Microscopical Examination," by Mr. E. T. Newton.

April 13. "Microscopical Vision," by Mr. W. T. Suffolk.

May 11. "The Structure of Mosses," by Dr Braithwaite.

These demonstrations afforded the means of communicating a great amount of information not easily obtained from text books. They were fully illustrated by drawings, specimens, and apparatus, and proved so attractive as to warrant their continuance at suitable intervals in the future.

Reports of these Demonstrations will appear in the Journal.

The following is a list of the works added to the Library by donation, exchange, and purchase:—

	Presented by
"Catalogue of Books, &c., on the Diatomaceæ	Mr. Julien Deby.
"Marshall on the Frog"	Mr. J. W. Groves.
"Medical and Surgical History of the Wars of the Rebellion." Vol. 2	U.S. Government.
"Transactions of the Linnean Society" ...	Mr. F. Crisp.
"Journal of the Linnean Society"	Mr. T. Charters White.
"Dr. Braithwaite's British Moss Flora." Part 6	The Author.
"Dr. Cooke's Myxomycetes of Great Britain"	"
"Hardwicke's Science Gossip"...	The Publisher.
"Proceedings of the Royal Society"	The Society.
"Journal of the Microscopical Society" ...	"
"Dr. Bowerbank's Sponges." Vol. 4	Subscription Ray Society.
"Cameron's Phytophagous Hymenoptera," Vol. 1	"
"American Naturalist"	In Exchange
"American Monthly Microscopical Journal"...	" "
"Northern Microscopist," 1882	The Publisher.
"T. Rupert Jones's Catalogue of Fossil Foraminifera in the British Museum"	Purchased.
"Dippel on the Microscope"	"
"Smith's British Botany," Vol. 16-18, Mosses	"
"Pasteur's Studies on Fermentation" ...	"
"Cole's Studies in Microscopical Science" (Completion of Volume)	"
"Mr. Saville Kent's Manual of the Infusoria" (Completion of Volume)	"
"Micrographic Dictionary" (Completion of Volume)...	"
"Challenger Reports," Vol. 5-6	"
"Van Heurcks Belgian Diatoms," Part 6. ...	"
"Quarterly Journal of Microscopical Science"	"
"Annals of Natural History"	"
"Grevillea"	"
"Dr. Cooke's British Fresh Water Algæ," Parts 3-5	"

Reports and Proceedings of various Societies.

A new Catalogue has been prepared by the Hon. Librarian, and will be issued with the present Report.

The following slides have been presented for the Cabinet :—

By Mr. J. Clark	1
„ The Dinner Committee	7
„ Mr H. H. Dobson	2
„ Mr. J. D. Hardy	3
„ Mr. H. Hensoldt	3
„ Mr. Joshua	3
„ Mr. F. Kitton	24
„ Mrs. Moginie	12
„ Mr. F. W. Morris	12
„ Dr. Partridge	4
„ Mr B. W. Priest	5
	76

In addition to these we possess, by subscription, the admirable specimens accompanying Mr. A. C. Cole's "Studies in Microscopical Science."

The donation by Mr. E. M. Nelson of one of the late Mr. Nobert's 19 band test plates deserves special mention, on account both of its great intrinsic and its historical value.

The excursions have proved attractive and productive, the weather having for the most part been favourable for them. In particular the day excursion to Whitstable was highly successful.

The spoliation of many favourite localities, for example that near Snaresbrook, is a matter of great regret, and the efforts of all who are interested in the study of microscopical life should be directed to securing, wherever practicable, the preservation of such places in their natural condition.

The great delay in the issue of the Journal has been occasioned by the long-continued indisposition of your Secretary. His retirement from the office of Editor, the duties of which Mr. Hailes has now undertaken, will no doubt put an end to such delays in the future. The numbers now in the press record the proceedings down to the meeting of April 27th, and the remainder to the present date will be published as speedily as possible.

Your Committee have invested an additional sum of £40 out of the subscriptions in new three per cent. annuities, making an amount of £80 available for any special requirements. The remainder of

the entire sum of £140 now invested is not so available, as it consists of compounding subscriptions, of which the dividends only can be applied to the general purposes of the Club.

The special exhibition meeting, held by the kind permission of the College on the 30th of March, was no less successful than those previously held; the character of the exhibits was well supported, and great interest was taken in them by the members and visitors.

The permission to hold our meetings here has been again renewed for the ensuing year, with the same courtesy and kindness that has characterised all the dealings of the Council of University College with the Club.

The social gatherings of the members have not hitherto been referred to in the reports, it being considered that they were somewhat apart from the regular work of the Club, though of acknowledged value in sustaining its friendly and genial character. Your Committee, however, consider that these meetings should now be officially recognised, and that it will tend to promote the interests of the Club if they are subject to its direction.

The excursionists annual dinner in the summer, and the members dinner in London in the winter, will therefore in future be held under the direction of a duly appointed Sub-Committee.

Your Committee desire to thank the officers of the Club for their services during the past year, and also those members who gave the Elementary Demonstrations at no inconsiderable cost of time and labour.

Your Committee hope that the revival of energy in the Club, to which they have already referred, will be continued in future, with the result of increasing the efficiency and influence of the Club as a centre of instruction in matters connected with microscopical investigations, which now occupies so important a place among the studies of the present day.

TREASURER'S STATEMENT OF ACCOUNT.

Dr. June 30, 1883.	£	s.	d.	Cr. June 30, 1883.	£	s.	d.
To Balance in hand, July 1, 1882	108	12	8	By Printing and Stationery...	19	0	0
Subscriptions	235	11	0	Postage, Carriage, &c.	6	1	4
Dividends on Compounding Subscriptions ...	3	2	2	Attendance, Lighting, and College Expenses ...	23	18	6
Sale of Journals	6	16	2	Property purchased	31	1	5
				Subscriptions invested	40	0	0
				Journal	116	15	10
				Expenses of Special Exhibition Meeting ...	11	0	3
				Petty Expenses	2	0	3
				Balance	104	4	5
	£354	2	0		£354	2	0

Amount invested in New Three Per Cent. Annuities, £140.

We, the undersigned, having examined the above statement of Income and Expenditure, and the vouchers relating thereto, hereby certify the same to be correct.

Signed,

WM. HAINWORTH,
H. H. DOBSON, } Auditors.

July 25, 1883.

PROCEEDINGS.

Friday, May 11th, 1883.—Conversational Meeting.

The sixth and concluding demonstration of the series was given this evening by Robert Braithwaite, M.D., F.L.S., on "The Structure of Mosses."

In his opening remarks, Dr. Braithwaite observed that he had great pleasure in acceding to the request of the Committee that he should give a demonstration on the structure of mosses, inasmuch as it was at the suggestion of the President that he had made his first essay on the subject; and further, that would probably be the last opportunity he would have of speaking about these matters in public; and he could now speak with the additional experience he had gained by working at the subject for some years past.

The mosses, looked at in a broad sense, formed an enormous aggregate of species, probably 10,000 in number, scattered over the whole earth, and especially delighting in wastes, woods, water-courses, rocks, and such like places, where there was always a large amount of moisture. They might be defined as cellular leafy cryptogamous plants, having the fruit enclosed in a calyptra, through which it bursts, and a capsule containing spores. But under this term were comprised various branches, and naturally the whole group fell into three great sub-classes.

First, *Sphagninæ*, or Peat Mosses.

The peat mosses contain a single genus Sphagnum, comprising 50 or 60 species. It differs from all the other groups in the structure of the leaves, which have heteromorphous cells, or cells of two distinct forms. In most cases the large or hyaline cells contain spiral fibres, but that is not an essential condition. The leaf cells of the Sphagninæ are of a sigmoid shape, and contain between their walls smaller cells which give the colour to the leaves. The larger cells contain spiral fibres, and usually holes or pores abound in the outer walls; the smaller cells contain chlorophyl, which gives the colour of crimson, or brown, or green to the plant. The branches are given off in fascicles or bundles, and the bark has a highly developed structure—one, two, three, or four layers of vesicular cells, with pores between, which form a distinct cuticle or bark, differing in this respect from the other mosses. The fruit has the ordinary urn-shaped capsule, throwing off the lid, and a calyptra, but without any peristome.

The second group is the *Hepaticinæ*, or Liver Mosses.

These are also thallaceous in a few cases, and they differ from the true mosses in having leaves lobed, imbricated in two rows, and the fruit case usually divided into four valves, and the spores have spiral fibres round them.

The third group, to which he should confine himself, is the *Bryinæ*. These are the frondose, or true mosses.

The true mosses number some 8,000 or 9,000 species, and they naturally fall into two divisions, which are readily known with a little practice, and are very convenient for the purpose of classification.

1. *Acrocarpi*.
2. *Pleurocarpi*.

The acrocarpi have the fruit rising from the termination of the stem, as in the well-known *Polytrichum commune*.

The pleurocarpi are branched laterally, and have the fruit rising from the side, as in *Hypnum*.

In earlier times the mosses were divided by the peristome or fringe round the mouth of the capsule, and it was considered only necessary to count the teeth, or see if the capsule did not open, thus forming a very convenient number of genera, but bringing together the most heterogeneous species.

The first writer to make an alteration in the classification was his friend Dr. Spruce, the famous South American traveller, in his work on the mosses of the Pyrenees in 1848. He published his ideas that the *cleistocarpi*, the capsules of which never open, but merely crumble to pieces, and the *gymnostomi*, or those with a naked mouth to the capsule, were merely less perfectly developed individuals of higher genera, and therefore should no longer be retained as separate genera of mosses. This was followed up by other great bryologists, and it is undoubtedly the most philosophical way of viewing the subject.

Among the acrocarpi we get one genus *Andreæa*, which has the capsule splitting at the side into four or eight valves, the capsule not opening at the top or bottom. This constitutes the section *Schistocarpi*, or split fruited mosses.

It is a great advantage to divide off species which have well defined characteristics, and this the valvular fruit enables us to do with the *Schistocarpi*, although by the leaves they are allied to *Grimmia*.

The fruit of all the great bulk of the mosses is stegocarporous, or provided with a lid, which is thrown off to give exit to the spores, and only in a few cases do we find the lid wanting, and the spores obtaining freedom by the decay of the capsule wall; these are termed the *Cleistocarpi*, which minute mosses are undoubtedly low conditions of more highly organized families. In some cases a lid is present, although it never separates at all, which is one step above the lowest form seen in *Ephemerum*.

In the higher mosses we get two very distinct forms of peristome, one the *Nematodontes*, characteristic of the *Polytrichum* family, and a few other allied mosses. The *Polytrichum* has teeth with threads from the top of one tooth through the base up into the next, and each tooth consists entirely of these threads united by cellular material, and fixed to the drum-like head of the columella.

The other great group is *Arthrodontes*, or jointed tooth mosses. These joints enable the teeth to bend in and out, giving them the beautiful hygroscopic character common to them, closing in wet weather and opening

in dry weather. If a transverse section is made of one of these teeth, it is found to consist of two rows of cells, divided by a central line, often having little holes or split into two forks; but behind this outer layer of coloured cells is an inner row of soft bladdery cells. It is to the action of these internal cells the teeth owe their hygroscopic nature. When the cells are filled with water they pull the teeth inwards.

In describing mosses the best way is to begin with the seed or spore. This is very minute, and almost always of a globular form, sometimes covered with little warts, sometimes smooth. In germination, the outer coat having given way the inner sac protrudes, and bye and bye presents a jointed thread, from which branches go off in various directions, and in time it becomes a complete bunch of threads. This is called the protonema.

In all true mosses it has this form. In the Hepaticæ it takes a thalloid form. From this the young moss begins to grow, and from one of these sometimes will be found 20, or 50, or 100 young plants, all springing from the protonema, or prothallium. Occasionally there is no fruit. In that case the protonema is capable of being developed from roots, leaves, and buds; a single living cell is capable of producing a new colony of plants.

In *Funaria* the old leaves fall off, and their basal cells will throw out threads of protonema.

As to the arrangement of the leaves, a very few have leaves in two rows. One the *Schistostega*, and the other the great genus *Fissidens*.

The *Fissidens* were very peculiar from the formation of the leaves; which are, as it were, double, and clasp the stem. Some extraordinary ideas had been published as to how this was produced. Carl Müller thought that the small double part was the true leaf and the rest an outgrowth of the nerve, which grew on and threw out an extension at the point and on the back, and he called these the apical and dorsal laminæ, the double portion being the true lamina of the leaf. Another thought that the leaf split in order to admit the stem. But if the leaf were so split this portion would naturally be thinner than the other, and not contain the same number of cell-layers, but in this case each half had the same thickness as the rest. His friend Lindberg had put it in its true light; he considers that the leaf has its natural form, but placed edgewise, a row on each side of the stem, and to each leaf is united a stipule, thus forming the double part, so that in reality there are four rows of leaves, two of large size and two of small size on the back, and these became adherent. That appeared the simplest view of the matter.

The leaf consists entirely of cells, which vary in form. There are two principal forms, one prosenchymatous, ending in points, very commonly hexagonal cells; the other parenchymatous, having a square end, quadrate or rectangular cells, and in that way is built up the tissue of the leaf. Sometimes the lower part of the leaf has one kind of cell and higher up the other. Sometimes it is so much thickened that the cells look like so many dots, which is due to a thickening process in the cell. The surface of these cells, and therefore of the whole leaf, might be quite smooth, or it might project into several forms of papillæ.

These were of three kinds, which were shown under the microscopes on the table. In one case the whole substance of the cell stands up like a little cushion; these are termed pulvinate or cushioned. Another kind has the cuticle of the cell rising up and taking the form of conical papillæ; while the third was the verruciform, or wart-like papilla. These are all very characteristic of various families; thus the verruciform papillæ are seen in *Encalypta*, and it belongs no doubt to the *Tortulaceæ*, or screw mosses, which have this kind of cell.

A nerve may be present, or none at all, and there may be two, or even three or four. The nerve may have several layers of cells, and extend half-way up the leaf, or to the point, and often it is longer than the leaf, and appears as a hair, which forms long white points to the leaves, and gives them a hoary aspect.

The margin of the leaf may be perfectly smooth or entire, or serrated, or thickened, or bordered with cells of other forms.

All these features were most important, because the specific character depended in most cases upon the leaves, and he laid great stress upon their microscopic structure. This was so far more important than the size and colour of the plant, because it had absolute definite structure impressed upon it from its first formation.

Then as to the reproductive system, the modes in which the plants continued their kind.

The mosses are termed cryptogams, so named by Linnæus. But the mode by which the impregnation of mosses is accomplished is not concealed, but simple, and easily traced. They have distinct male and female organs, which are termed *antheridia* in the male, and *archegonia* in the female. In the family of the Polytrichaceæ the antheridia appear as beautiful little sausage-shaped bodies in separate rosettes, or clusters of leaves, usually differing from the stem leaves and termed bracts. In flowering plants the floral leaf is termed a bract, and he did not see why the same term should not be applied to mosses. In some cases the male and female organs are on separate parts of the plants, and in other cases the male organs are on one plant and the female on another. In this way there are formed three groups, which are termed *Synoicous* where the sexual organs were found together in one inflorescence, *Monoicous* where the male and female are on separate parts of the same plant, and *Dioicous* where the male and female organs are found on separate plants.

Around this inflorescence there is usually found a beautiful cluster of long threads termed *paraphyses*. These have been usually considered abortive antheridia, but their purpose no doubt is to maintain moisture round these organs. It will be found, even in dry weather that fluid mucous matter is always present; in his mind the object is to maintain the vitality of the antheridia.

The archegonia are more like a flask with a long neck, and they also have paraphyses round them. As time goes on the little top bursts, and it is found that a long channel has been formed down the centre to the dilated base, which always contains a large central cell. The antheridium also

bursts, and from it is given off a cloud of fine particles, which are the spermatozoids, coiled up and swarming about. These have been observed to pass down to the central cell, where they are absorbed.

No sooner has the central cell become impregnated than the upper part withers and the large central cell begins to grow and develop. As it grows it pushes off and breaks away the covering skin. It does not begin to enlarge until it has continued growing some time, and then, the seta having attained its full height, begins to expand. This at the top forms the calyptra and capsule, the little sheath at the bottom is called the vaginula, the leaves round it are termed the perichætium.

The seta having attained its growth, the capsule begins to enlarge, the calyptra expands, resting on the top of the lid, and taking various shapes according to the way the capsule stretches it. In some cases it is simply split up. Sometimes it is of a conical form, and splits up because there is no room for the capsule within it, as in the *Funaria ;* in *Encalypta* it comes off as a small cone or extinguisher.

The calyptra being thrown off the capsule is seen in its natural condition, closed in most cases by a lid or operculum, sometimes of a conical shape sometimes with a very long beak. In a few cases, as in *Phascum*, the capsule is always globular, and a mass of spores escapes through an opening caused by the rotting of the plant. Sometimes the capsule drops off the stalk, leaving a little hole at the bottom through which the spores escape.

The lid of the capsule falling off, there appears the beautiful appendage, which has been termed the peristome, with a number of teeth, commonly sixteen, standing up or spreading out in various directions. This is termed a single or double peristome according as it has one or two rows of teeth. In some cases the interior is membranous. He preferred to call the interior row the endostome, within the mouth, for this reason ; if a vertical section be made of the capsule of *Mnium* it will be found that the outer row of teeth of the peristome springs from the inner wall of the capsule, but where there is a second row, that springs from the wall of the spore sac. He also noticed another part of the interior of the spore sac, namely the columella or central pillar, from which the operculum or lid has been thrown off. In some cases it runs up to the top of the peristome, and expands into a membrane, closing the mouth of the capsule.

In the beautiful family of the *Polytrichums* this columella takes various forms. In some cases it has wings, in others the spore sac is attached to the wall with jointed threads, which act as ropes or stays.

There are two modifications of the peristome, as already mentioned.

In cases where the mouth of the capsule is naked, as in the gymnostomous mosses, by the plan formerly adopted these mosses are separated from genera to which they are otherwise closely allied ; but in very many cases it is not possible to see the peristome or even the fruit, yet by the leaves and habit of the plant they can be placed with mosses which have a peristome, and to which they are otherwise perfectly related. In all these cases the spores are contained in a bag or spore sac, and when the lid comes off the spores pour out. These organs are most distinct and easily examined.

One great advantage in studying mosses is that they are always expansible when put into water. Some mosses he had seen, gathered in 1680, were capable of being perfectly examined at the present time.

He would recommend the preparation of good specimens; there would always be satisfaction and enjoyment in looking at them. Always get plenty of material; many people take an interest in the same things who are not able to collect for themselves.

There were various ways of mounting; he should mention Rabenhorst's European mosses as an example of good arrangement for a collection of mosses.

For his own collection he used demy paper in single sheets, on which he mounted 6, 8, 10, or 12 specimens. These he enclosed in covers for genera, and these in stout pasteboard cases for families. With this arrangement it is easy to add new varieties or new species.

It is also an advantage to have some specimens in capsules loose so as to transfer them to the microscope and observe them without any trouble, and others, which are so small as to be difficult to mount on paper, can be preserved this way in safety.

With regard to examination, a couching needle used by oculists was useful; it was possible to make transverse sections of the leaves with this, placing the moss on a slip and using a pocket lens. With a double edged thin blade it was easy to see where to cut, and sections of the smallest leaves can be made without difficulty. The sections should be transferred to the microscope in water.

Another use for these needles was taking leaves from the stem; after wetting the leaves it is easy to transfer them to water without tearing them.

For permanent mounting he preferred glycerine jelly. All those shown under the microscopes were mounted in glycerine jelly. Rimmington's glycerine jelly is very pure, and well made. Immerse the moss in clean water, exactly as it is desired to mount it, quickly transfer to a clean slip, on which is dropped a little jelly sufficiently heated to melt it; place on the cover, and there will be no difficulty in making a good mount, which can be finished off with rings of gold size, and kept as long as desired.

Mr. Ollard inquired how the moss should be dried.

Dr. Braithwaite explained that it was only necessary to wash away the sand, &c., press out the water in a folded towel, and then press quickly in drying paper.

He mentioned that at the Kew Museum they were preparing examples of the British Mosses exactly as they grew, so as to illustrate the families.

The President, in announcing the close of this series of demonstrations, thought all would agree with him that they had proved most satisfactory, both as to the way they had been carried out and the interest excited among the members, and the Club was much indebted to the gentlemen who had given the demonstrations. He asked for a hearty vote of thanks to Dr. Braithwaite for his address, which was carried in the usual way.

The following specimens were exhibited by Dr. Braithwaite in illustration

of his demonstration, several Members lending their microscopes for the occasion:—

Sphagnum subsecundum. Cells of two forms large porose, empty, fibriferous, bordered by very narrow chlorophyllose.

Protonema of *Mnium punctatum* and *Ephemerum cohærens.*

Schistostega osmundacea. Leaves in two rows; cells prosenchymatous.

Fissidens Orrii. Leaves in two rows, with two rows of stipules united to them.

Cinclidium subrotundum. Leaves with a thickened border.

Voitia nivalis. Cells parenchymatous.

Hookeria lucens. Leaf nerveless, throwing out roots. Cells prosenchymatous, plane and smooth, chlorophyllose, lumen very large.

Andreæa alpina. Leaves nerveless. Cells pulvinate, incrassate, lumen very small.

Thuyidium tamariscifolium. Leaves nerved papillose; each cell elevated into an acute papilla.

Encalypta streptocarpa. Cells incrassate verrucose, each developing a cleft wart from the cuticle.

Dicranum molle. Leaf with large quadrate brown basal angular cells.

Leucobryum glaucum. Transverse section of leaf. Almost all a nerve, composed of two layers of large empty cells communicating by pores, and a central series of angular ducts.

Fissidens serrulatus. Male inflorescence; Antheridia and perigonial bracts.

Georgia geniculata. Peristome (Nematodont) 4 solid lamellar teeth.

Fissidens adiantoides. Peristome (Arthrodont) 16 jointed forked teeth.

Catharinea undulata. Peristome (Nematodont) 32 solid lamellar teeth.

The following objects were also exhibited:—

Tegeocranus latus, Nymph	Mr. F. W. Andrew.
Pith of *Aralia Vapyrifera*	Mr. J. W. Hardy.
Corinna elegans showing two frustules still cohering	Mr. H. Morland.
Asplancha Brightwellii, without vibratory tags, from Caterham Excursion ...	Mr. J. M. Offord.
Cuticle of Pelargonium	Mr. J. A. Ollard.
Petiole of Carrot, transverse section, double stained	Mr. W. D. Smith.
Ova, and newly hatched Perch	Mr. A. W. Stokes.

(Specimens of these were distributed among the members.)

Fresh-water Medusa, *Craspedacustes Sowerbyii* vel *Limnocodium Victoria*, from Victoria Regia Tank, Botanical Gardens	Mr. H. J. Waddington.

Attendance—Members, 49; Visitors, 11

May 25th, 1883.—Ordinary Meeting.

Dr. M. C. Cooke, M.A., A.L.S., President, in the Chair.

The minutes of the preceding meeting were read and confirmed.

The following gentlemen were balloted for, and duly elected members of the Club :—Mr. T. E. Barratt, Mr. C. A. Drake, Mr. G. E. Mainland, Mr. H. C. Mais, and Mr. W. R. Sharer.

The following donations to the Club were announced :—

"Proceedings of the Linnean Society" ...	From Mr. T. C. White.
"Proceedings of the Belgian Microscopical Society"	,, the Society.
"Science Gossip"	,, ,, Publisher.
"The Analyst"	,, ,, Editor.
"The American Naturalist"	In exchange.
"The American Monthly Microscopical Journal"	,, ,,
"Van Heurck's Belgian Diatoms"	Purchased.
"Quarterly Journal of Microscopical Science"	,,
"Annals of Natural History"	,,
"Cole's Studies in Microscopical Science"...	,,
One Slide—Section of Kawri Pine from New Zealand	From Mr. Clarke.

The thanks of the Society were unanimously voted to the donors.

The Secretary said they would no doubt be pleased to hear something of one of their members, Dr. Whittell, who had recently returned to Australia, and had forwarded thence a newspaper containing a report of a paper, which he had read at Adelaide, "On a Compound Ascidian." This newspaper also contained an account of a discussion which had taken place at a meeting of the Farmers' Association on seed pickling as a means of keeping wheat from the attacks of fungi.

The Secretary then read the following extracts :—

"Mr. H. Whittell, M.D., then read a paper on the 'Dissection of a Compound Ascidian,' which he believed to be undescribed, and of which he had recently found two specimens near the Glenelg Jetty. Each animal of the composite structure had a separate opening through the external test, and the pharyngeal sac admitted of such easy separation as to afford a perfect view of its structure. A peculiar feature of this sac is that in addition to the usual leaf-like expansions at the mouth there are to be seen, just within the cavity, a large number of long curling tentacles, which, like those of polyzoa, are evidently retractile. In a few of the best examples some of these can be seen protruded some distance through the mouth. Within the deeper parts numerous young embryos are found. These all have long tails, which disappear as the animal advances in development. It was explained that in some ascidians the tail remains permanent, and that many naturalists believe that the close resemblance between these forms and some of the lowest types of fish justified the

classification of ascidians in the chain of evolution as the connecting link between the invertebrate and vertebrate types. After the reading of the paper microscopical specimens illustrating the minuter details of structure were exhibited."

"SEED PICKLE.—Mr. Lawrie brought forward the question of the best pickle for seeding. Most persons used bluestone, but it was a question whether that was the best. He had pickled with Dollman's Farmer's Friend, and had 28, 20, and 16 bushels an acre. When he came to Napperby he had pickled solely with salt, and his neighbour (Mr. Ward) had used bluestone, and had much less than he did. He (Mr. Lawrie) did not think bluestone the best pickle, as it injured the grain, and he thought some sort of pickle might be got which would be better than bluestone. Perhaps some other members would give their experience. Mr. G. Lovelock had tried different methods of pickling, and found bluestone the best for preventing smut. If, however, the land was clean, he considered it best to sow perfectly dry. Mr. J. Ward's experience was that if wheat pickled with bluestone got wet it was not fit for pigs. Mr. Lovelock thought bluestone a preventative of smut, but it injured the grain. He intended this year to wash some smutty wheat, and see what effect that would have. Mr. Lawrie hoped something would be found which would feed the grain instead of detracting from its power. The question of lime pickle was mentioned, and the subject dropped."

The President said that the wheat disease referred to was the ordinary form of "rust," which, he believed, no amount of washing would be likely to remove. For "bunt" it was a good practice to dress with sulphate of copper, but rust was so perfectly an organic disease that no amount of dressing was likely to be effectual.

The President then read a list of the various objects found during the excursion of the Club to Keston on May 19th, and exhibited a coloured drawing of the chief forms of fresh-water algæ met with on that occasion.

Mr. E. M. Nelson exhibited and described a new method of fixing objectives to the microscope, to obviate the trouble and time needed in the usual mode of screwing. It was much simpler than the one which he described to the Club in September last,* and was made on the principle of the bayonet joint. A collar, provided with three radially projecting pins, equi-distant apart, was screwed upon the object glass. The adapter was made with an external screw of the standard gauge, so as to screw into the nose of the microscope, and was formed with three annular grooves on the inside, into which grooves led three vertical notches. The annular grooves were slightly inclined, so that by inserting the three pins on the objective collar and giving the objective a partial turn it was firmly secured in place.

Mr. Ingpen said with regard to the exact position of the objective this method of fixing was of importance, for if the objective did not properly centre, no shifting of the eye-piece was likely to correct it. If an objective centred correctly, the centering of the eye-piece was a matter of much

* See page 152.

less importance, as it would be found that they might shift the eye-piece laterally without making much apparent difference.

Dr. Matthews said that in connection with the question of the simplest mode of attachment it occurred to him that there was an instrument in common use, a stomach pump, in which the joints fitted together as cones, and so perfect did this method seem that he never knew a case in which a joint had given way. If the objective and nose-piece were fitted together in this manner by a cone of sufficiently small angle, he could conceive of nothing more simple which could be adapted to the purpose.

Mr. Hailes said there seemed to be considerable analogy between the fitting of an objective and the chucks of a lathe. It was well known that if work was removed from a lathe fitted with an ordinary screw chuck it was almost impossible to bring it up to truth again by screwing up. With respect however to the cone fitting, he was speaking about it a short time ago to the proprietor of a large engineering works, and that gentleman told him he considered it the best fitting for lathes that could possibly be used, and he had done away entirely with screwed nose-pieces in favour of the cone. As to its power of holding, he, Mr Hailes, might say that he saw a 1in. iron bolt screwed perfectly at one cut with dies held in a chuck so fitted, and he was told that with this kind of fitting the chuck could be taken off and replaced with perfect accuracy.

Dr. Matthews said he had often seen this difficulty of getting the same degree of truth when replacing work in the lathe with the shoulder screw, and had noticed that a workman would use a piece of brown paper packing in order to get exactly the same adjustment as before.

Mr. Nelson said that he believed the reason why Powell and Lealand's lenses fitted into their bodies so absolutely true was that they made all of them to screw up to exactly the same point of the screw. But when an objective of another optician's make was put upon one of their bodies, though it was the same thread, it would not screw up with the same degree of accuracy. All depended upon the point at which the screw came up to the shoulder. With regard to the cone, he believed it to be the best fitting in the world, and for his own part he should be glad to see the whole system of screws swept away and the cone substituted.

Mr. T. Curties exhibited and explained the action of Pease's "Facility" adapter, in which three gripping jaws are caused to advance and recede on turning a loose collar, somewhat in the fashion of the well-known American "grip" chuck for lathes. A grooved ring is screwed upon the object glass, which only then requires to be inserted into the adapter, when a partial turn of the loose collar accurately centres and secures it in its place. Mr. Curties also exhibited a modification of this, which he had had made. In this modification the gripping jaws were made somewhat wider, and were threaded on the inside, so that they might grip the screw thread on the objective, thereby doing away with the necessity for the grooved ring of Pease's arrangement. He thought this form offered the very great advantage of saving the time and trouble of screwing and unscrewing in about as simple and complete a manner as could be devised.

Mr. Ingpen thought the members would be very glad to have the opportunity of seeing and comparing these various plans, for it was particularly the province of societies like theirs to deal with things of this kind. No doubt the American plan was very pleasant to use, but he thought Mr. Nelson's new device was a great improvement upon his former plan, and at the same time had the very particular advantage that it need not cost very much.

The thanks of the meeting were unanimously voted to Mr. Nelson and Mr. Curties for their communications.

Mr. Nelson read a paper "On the Cause of some Errors in the Interpretation of Small Microscopical Objects."*

Mr. Ingpen said that the question of entoptic shadows was one of much interest and importance. The lines seen round an object as described by Mr. Nelson were analogous to the diffraction lines seen round the images of stars in a telescope.

Mr. Michael thought he had understood Mr. Nelson to say that the cone of rays arising from a condenser should be suited to the angle of the objective, and also to say that the No. 6 hole was suited to most objectives, these two statements seeming to be at variance.

Mr. Nelson said this raised a most interesting question. He had no doubt that if they could have an absolutely perfect objective they would get the best performance from rays which came at the same angle as that of its aperture, but in practice this could not be realized, because the marginal zones were not the same as the central.

Mr. Ingpen thought that Dr. Fripp did not mean, so far as he knew, that the whole aperture of the condenser should be used, but that it must have an aperture equal to that of the objective, so that light of any required obliquity might be obtained. No doubt Mr. Nelson's idea was a new and important point of departure.

Mr. Michael did not think that Dr. Fripp contended that the whole aperture should be used, but rather that the aperture of the condenser should vary according to that of the objective; that was that they should be suited to one another.

The thanks of the meeting were voted to Mr. Nelson for his communication.

The President announced that the meeting was favoured that evening by the presence of Dr. Josiah Curtis, of Washington, to whom, in the name of the members, he gave a hearty welcome.

Dr. Curtis said it afforded him the greatest pleasure to meet them on that occasion. The Quekett Club was so well known that he was most happy to bear his testimony to its reputation in America for the life, energy, and activity with which it pursued its subjects of investigation.

The President announced the meetings and excursions for the ensuing month, and called special attention to the whole day excursion to Whitstable on June 2nd and to the excursionists' annual dinner on June 30th. Members were also reminded that at the next ordinary meeting, nominations

* This paper has been unavoidably delayed, but will appear in our next issue.—Ed.

would be made for officers and Committee to be elected at the annual meeting in July, five vacancies on the Committee having to be filled up by gentlemen nominated by the members themselves.

Mr. Hembry said that special arrangements had been made as to railway fares on the occasion of the excursion to Whitstable. He had written to the London, Chatham, and Dover Railway Company, and had heard from them that they would be pleased to provide tickets for members of the party at 4s. 11d. each for the day excursion, or 1s. extra if it was desired to return on Monday.

Mr. T. C. White said he should advise those members who went down to Whitstable to provide themselves with good extra pairs of waterproof boots, as after wading in the salt marshes they would be apt to come away with a good deal of mud attached.

Mr. Curties mentioned that this was an occasion on which the East Kent Society took the opportunity of meeting the Quekett, and that a well-known gentleman from Canterbury usually conducted them.

Mr. Hembry said that Mr. Saunders had promised to conduct the party for the entire day.

The proceedings then terminated with the usual conversazione, when the following objects were exhibited :—

Resin passages in section of Stem of *Abies excelsa*, double stained	Mr. F. W. Andrew.
A gathering of Desmidiaceæ from Keston ...	Mr. E. Dadswell.
Section of Ovary of *Pyrus Japonica*, stained	Mr. H. E. Freeman.
Stephanoceros Eichhornii	Mr. H. R. Gregory.
Bursaria truncatella, fixed by tannin, showing structure and cilia	Mr. J. D. Hardy.

Attendance—Members, 44; Visitors, 4.

June 8th, 1883.—Conversational Meeting.

The following objects were exhibited :—

Spirogyra nitida, in conjugation	The President.
Section of Marble, polarised	Mr. F. W. Andrew.
Foraminifera from Galway. New species— *Lagena faba*, *L. trigona-faba*, *L. trigona-bicarinata*, *L. trigona-pulchella*, and *Rimulina, Sp.* New to Britain— *Polymorphina complanata*, D'Orb.; *Lagena clathrata*, Brady; *L. fimbriata*, Brady; *L. bicarinata*, Terq.; and *L. lagenoides*, var. *tenuistriata*, Brady.	Messrs. Balkwill and Millett.
Colorado Beetle	Mr. A. Button.
Isolated annular cells from *Opuntia*	Mr. W. I. Curties.

Photographs of New Zealand scenery	...	Mr. A. Durrand.
Chelifer cancroides (alive)	...	Mr. H. E. Freeman.
Conferva—*Chætophora elegans*... ...	...	Mr. H. R. Gregory.
Plumularia, killed by tannin	...	Mr. J. D. Hardy.
Polycistina (with Chromatoscope) ...	...	Mr. G. E. Mainland.
Rare form of *Trinacria* from Jutland...	...	Mr. E. M. Nelson.
Cuticle of Pelargonium...	...	Mr. J. A. Ollard.
Eggs of Stone Mite	...	Mr. G. D. Plomer.

Attendance—Members, 43; Visitors, 4.

June 22nd, 1883.—Ordinary Meeting.

Dr. M. C. Cooke, M.A., A.L.S., President, in the Chair.

The Chairman regretted to say that, owing to indisposition, their Secretary was unable to be in his usual place that evening; latest news of him, however, showed that he was better than he had been, and it was hoped that he would be present at their next meeting. Mr. Hailes had kindly consented to take his place *pro tem.*

Mr. Hailes read the minutes of the preceding meeting, which were duly confirmed and signed by the President.

The following gentlemen were balloted for and duly elected members of the Club:—Mr. G. C. Ash, Mr. A. E. Balleine, Mr. W. H. Burbridge, Mr. J. E. Hazlewood, and Mr. W. M. Young.

The following donations to the Club were announced:—

"The Medical and Surgical History of the War in the United States." Vol. 3	From the Army Medical Department, Washington.
"British Fresh-Water Algæ"	Purchased.
"The American Monthly Microscopical Journal"	From the Editor.
"Proceedings of the Royal Microscopical Society"	" the Society.
"Annals of Natural History"	Purchased.
"The American Naturalist"	In Exchange.
"Science Gossip"	From the Publisher.
"Proceedings of the Hampstead Naturalists' Club"	" the Society.
One Slide	From Mr. Clarke.
Two Slides	" Mr. Dobson.
Three Slides	" Mr. Hardy.
Three Slides (Algæ)	" Dr. M. C. Cooke.

The thanks of the meeting were returned to the donors.

The President reminded the members that their next meeting would be the Annual Meeting, at which they would be called upon to elect Officers and Members of Committee to fill vacancies in accordance with the rules. Nominations would have to be made at the present meeting, and in the

case of President and Officers, who would be nominated by the Committee, any member of the Club would be entitled to substitute other names upon the balloting papers if he wished to do so.

Mr. Hailes read the following list of nominations by the Committee :—

As President	Dr. M. C. Cooke.
„ Vice-Presidents ...	Messrs. Michael, Newton, Stewart, and White.
„ Treasurer	Mr. Gay.
„ Joint Secretaries ...	Mr. J. E. Ingpen and Mr. G. C. Karop.
„ Foreign Secretary ...	Mr. Hailes.
„ Reporter	Mr. R. T. Lewis.
„ Librarian	Mr. Alpheus Smith.
„ Curator	Mr. Emery.

The President said that there were five vacancies upon the Committee, in consequence of the retirement of Messrs. Gilburt, Michael, Newton, Reed, and Scofield, and invited the members present to nominate gentlemen to serve in their places.

The following nominations were then made :—

Mr. Hembry	proposed by Mr. Dadswell,	seconded by Mr. Priest.
Mr. H. R. Gregory	„ „ Mr. H. E. Freeman	„ „ Mr. Dunning.
Mr. Dadswell	„ „ Mr. Gregory	„ „ Dr. Matthews.
Rev. H. J. Fase	„ „ Mr. Curties	„ „ Mr. Waller.
Mr. H. J. Waddington	„ „ Mr. Parsons	„ „ Mr. Dobson.

The President said their next duty would be to elect two gentlemen as Auditors of their accounts. On the part of the Committee he appointed Mr. Hainworth, and asked the members to nominate some other gentleman to act with him on their behalf.

Mr. Dobson was then proposed by Mr. Willson, seconded by Mr. T. C. White, and unanimously elected Auditor on behalf of the Club.

The President said he had the pleasure of introducing to the meeting another of their Trans-atlantic friends, who had favoured them with his presence that evening—the Editor of the "American Monthly Microscopical Journal," Mr. Romyn Hitchcock, of New York—whom he cordially welcomed amongst them, and invited to address the meeting.

Mr. Hitchcock, who on rising was warmly greeted by the meeting, spoke at considerable length, giving an interesting resumé of the work accomplished by the United States Coast Survey and the Fish Commission as to soundings, dredging, and deep sea thermometric observations. Reference was also made to the collections at present being shown in the United States Department of the International Fisheries Exhibition at South Kensington, and permission was freely given to any members of the Club to examine the specimens of sponge spicules, soundings, &c., which the exhibit included.

A cordial vote of thanks to Mr. Hitchcock for his communication was proposed by the President, and carried by acclamation.

Mr. Nelson exhibited a photomicrograph by Dr. Maddox of a specimen of "*Bacillus Subtilis*," and explained its peculiarities.

The President said he had with him some of the scales of a large Mada-

gascar moth, which he should be pleased to distribute to any members who were interested in them. He believed they were about the finest scales found on any moth or butterfly.

Meetings, &c., for the ensuing month were announced, and the proceedings terminated with the usual conversazione, at which the following objects were exhibited :—

Eggs of Garfish, attached to a fragment of Herring-net	By Mr. T. Curties.
Bacteria of putrefaction from Yam	,, Mr. W. I. Curties.
Sertularia, with polypes expanded	,, Mr. C. G. Dunning.
Small Harvestman, *Phalangium*	,, Mr. H. E. Freeman.
Limnias ceratophylli	,, Mr. C. Le Pelley.
Scarlet earth mite	,, Mr. T. S. Morten.
Coccus from an Orchid	,, Mr. F. A. Parsons.
Parasite of Stickleback...	,, Mr. A. W. Stokes.

Attendance—Members, 54; Visitors, 4.

Friday, July 13th, 1883.—Conversational Meeting.

The following objects were exhibited :—

Pollen of Passion Flower, mounted in glycerine	Mr. F. W. Andrew.
Section of Foot of three months Fœtus, showing formation of bone	Mr. W. I. Curties.
Young Perch	Mr. C. G. Dunning.
Oribata ♀ with eggs and ovipositor	Mr. H. E. Freeman.
Active molecules of Gamboge in water ...	Mr. H. G. Glasspoole.
Plumatella repens	Mr. W. Goodwin.
Stentor mulleri and *Limnias*	Mr. C. Le Pelley.
Spider	Mr. G. E. Mainland.
Triceratium maculatum...	Mr. H. Morland.
Deutzia leaf, and Cuticle of Pelargonium ...	Mr. J. A. Ollard.
Closterium rostratum in conjugation... ...	Mr. G. Sturt.

Attendance—Members, 42; Visitors, 2.

July 27th, 1883.—Annual Meeting.

Dr. M. C. Cooke, M.A., A.L.S., President, in the Chair

The Secretary read the minutes of the preceding meeting, which were confirmed by the members, and signed by the Chairman.

The following gentlemen were balloted for and duly elected members of the Club :—Mr. H. Barnes, Mr. A. Durrand, Mr. E. H. Goold, and Mr. E. J. Mansfield.

The following additions to the library and cabinet were announced :—

"Proceedings of the Royal Society"	From the Society.

"Proceedings of the Postal Microscopical Society"	From the Society.
"Twelfth Annual Report of the Chester Microscopical Society"	" "
"Annals of the Belgian Microscopical Society"	" "
"The American Monthly Microscopical Journal"	" the Editor.
"Dr. Braithwaite's British Moss Flora." Part 7	" the Author.
"Annals of Natural History"...	Purchased.
A new Compressorium	From Mr. J. D. Hardy.

The thanks of the meeting were voted to the donors.

Dr. Matthews exhibited another device for facilitating the exchange of objectives whilst working with the microscope. He said that several ingenious devices had been brought out from time to time for exchanging objectives without loss of time; the multiple nose-piece was one of these, and that had not succeeded on account of its weight and other difficulties. At a recent meeting Mr. Nelson and some other gentlemen had brought out some more simple contrivances, which seemed to answer the purpose, but it would perhaps be remembered that he had a long time ago mentioned a still more simple mode of adjusting objectives to nose-pieces, and he had now carried the plan into effect. It consisted of a short adapter in the form of a hollow cone, which was screwed into the ordinary nose-piece, and of another piece coned down exactly to fit inside the first one, which was screwed on the objective. The only action required was then just to push the one into the other, and as they fitted accurately there was quite sufficient adherence to keep the objective in its place. It was of course just possible that a blow might cause the objective to drop out, but this in practice was hardly likely to happen; there could be nothing more simple than this kind of attachment.

Mr. Ingpen was glad that Dr. Matthews had brought up this adapter, which was certainly extremely simple, and would be a form supplemental to what had been already described; time would no doubt show which of the various contrivances was really the best for general use.

Dr. Matthews, in reply to questions, stated that the arrangement was very inexpensive, the hollow cone could be kept on the nose-piece of the microscope, and the others screwed on the objectives, so that either could be used as required. The centering of the objectives was likely to be more accurate than if they were screwed on in the usual way.

Announcements of meetings, &c., for the ensuing month were then made, and the ordinary business terminated.

The meeting was then made special for the purposes of the 18th Annual General Meeting.

The Secretary read the 18th Annual Report, also the Treasurer's Annual Statement of Account for the past year.

Dr. Matthews in moving "that the Reports now read be received and

adopted, and that they be printed and circulated in the usual way," said that he was unable to avoid an expression of the regret which he was sure was felt by all in connection with the partial retirement of their worthy Secretary. It had been said, "the King is dead, long live the King," and so whilst they did not altogether lose their valued friend and coadjutor, Mr. Ingpen, they were happy in being able to welcome as his *confrère* a gentleman, who he felt sure would prove himself to be in every way worthy of the position, and to whom he offered a hearty welcome. He also felt he might draw their attention to the catalogue of the books in the library, which had been prepared by their friend Mr. Alpheus Smith, to whom they were so greatly indebted, and of whom it might be said that "the man who arranged our knowledge for us was almost more important than the man who possessed it."

The motion having been seconded by Mr. J. G. Waller, was put to the meeting by the Chairman, but before being carried,

Mr. Goodwin interposing, said he had been thinking over the matter in anticipation of the meeting, and wished just to make a few remarks, which he hoped would be received, as they were intended, in no unfriendly spirit. The fact that a catalogue of the contents of the library was in preparation would be a matter for satisfaction to all concerned, but he could not help remarking that beside the books there was a large quantity of apparatus of various kinds belonging to the Club. These things were introduced and exhibited at the meetings, thanks were voted to the donors of them, and then they disappeared! The Cabinet to which they were consigned was in fact to most of the members a "cabinet of mystery!" He thought this was hardly as it should be, but that it would be very much better if these articles were accessible to the members, as being objects and apparatus, which might be regarded as standards of comparison, available for the purpose of being consulted by intending purchasers of similar apparatus. It occurred to him, however, that in a club where they only repaid their officers by a vote of thanks, it was perhaps rather ungracious to ask them to undertake any other duties, but he would suggest that perhaps some member could be appointed as Curator of the instruments and accessories, to whom members could apply for what they wanted; and he thought it would also be very useful if a list of such apparatus as they possessed could be added to the catalogue, which was promised to appear shortly.

Mr. Ingpen said that as regards the last part of Mr. Goodwin's remarks, it appeared to him to be a good suggestion that they should have a published list of the apparatus; the point was one which seemed to have escaped their attention. As regards the collection itself, he thought it was rather a mistake to look upon it as a type collection; it had not been purchased or got together as such, but consisted of apparatus presented from time to time; there were amongst it two microscopes, together with a lot of odd objectives and accessories, the whole thing being of a very miscellaneous character, and not at all suited for purposes of comparison. As to advice to be given to enquirers, he could only say that if anyone had ever asked him a question on "glass and brass" matters he had always endeavoured to

give every information in his power, and he could only regret that so little use should be made of the large store of information in the possession of some of their members. All suggestions, however, were regarded as valuable, and would at all times receive the attention of the Committee.

The President having again put to the meeting the adoption of the reports, the motion was carried unanimously.

Mr. Parsons and Mr. F. H. Ward having been appointed Scrutineers, proceeded to the ballot for Officers and Committee for the ensuing year.

The President then delivered the Annual Address.

Mr. E. T. Newton said it was always a pleasant thing to propose something which one knew that all present would be agreed upon, and he had therefore great satisfaction in moving a hearty vote of thanks to the President for his admirable Address, and in requesting him to allow it to be printed and circulated with the report.

Mr. Dadswell having seconded the motion, it was put to the meeting by Mr. Newton, and carried by acclamation.

The President, in acknowledging the vote and acceding to its terms, said that in the preparation of his Address he had made use of two important works upon the subject, the "Metamorphoses of Man and the Lower Animals," by Quatrefages, and "Steenstrup's Alternation of Generations," which he now had much pleasure in presenting to the library.

Mr. F. W. Andrew moved a vote of thanks to the President, Officers, and Committee for their services during the past year.

Mr. Parsons having seconded the motion, it was put to the meeting, and carried unanimously.

The President having acknowledged the vote of thanks on behalf of himself and his colleagues, then said he had great pleasure in proposing one other vote which he was sure would be received by them as a substantial one, and accorded with very great satisfaction. Year after year they had been privileged to meet in that splendid room, and the fact was every time impressed upon them that they were indebted for the privilege to the Council of University College, whose universal kindness and courtesy could not be too highly appreciated. It was with confidence therefore that he asked the members to unanimously pass a vote of hearty thanks to the Council of University College for their continued permission to make use of the library for the purposes of their meetings.

The vote of thanks was then put and carried by acclamation.

A vote of thanks to the Auditors and Scrutineers having been proposed by Mr. Curties, and seconded by Mr. Goodwin, was put to the meeting and carried unanimously.

The President then announced that the following gentlemen were unanimously elected as Officers and Members of Committee for the ensuing year:—

PRESIDENT.—Dr. M. C. Cooke.

VICE-PRESIDENTS.—Messrs. A. D. Michael, E. T. Newton, Charles Stewart, and T. C. White.

Five New Members of Committee.—Mr. E. Dadswell, Rev. H. J. Fase, Messrs. H. R. Gregory, F. W. Hembry, and H. J. Waddington.

Hon. Treasurer.—Mr. F. W. Gay.

Hon. Secretaries.—Messrs. J. E. Ingpen, and G. C. Karop.

Hon. Secretary for Foreign Correspondence and Editor of Journal.—Mr. Henry F. Hailes.

Hon. Reporter.—Mr. R. T. Lewis.

Hon. Librarian.—Mr. Alpheus Smith.

Hon. Curator.—Mr. Charles Emery.

The proceedings then terminated with the usual Conversazione, when the following objects were exhibited:—

Section of stem of Bracken-fern, *Pteris aquilina*, double stained and polarised	Mr. F. W. Andrew.
Freshwater Medusa, *Limnocodium Sowerbii*, preserved by Squire's process ...	Mr. Frank Crisp.
Gall Mite from Lime Tree, *Phytoptus tiliæ*, alive	Mr. H. E. Freeman.
Scarlet Water Mite, alive	Mr. H. R. Gregory.

Attendance—Members, 50; Visitors, 0.

Circumnutation in Fungi.

By M. C. Cooke, M.A., A.L.S., President.

(*Read August 24th*, 1883.)

PLATE IX.

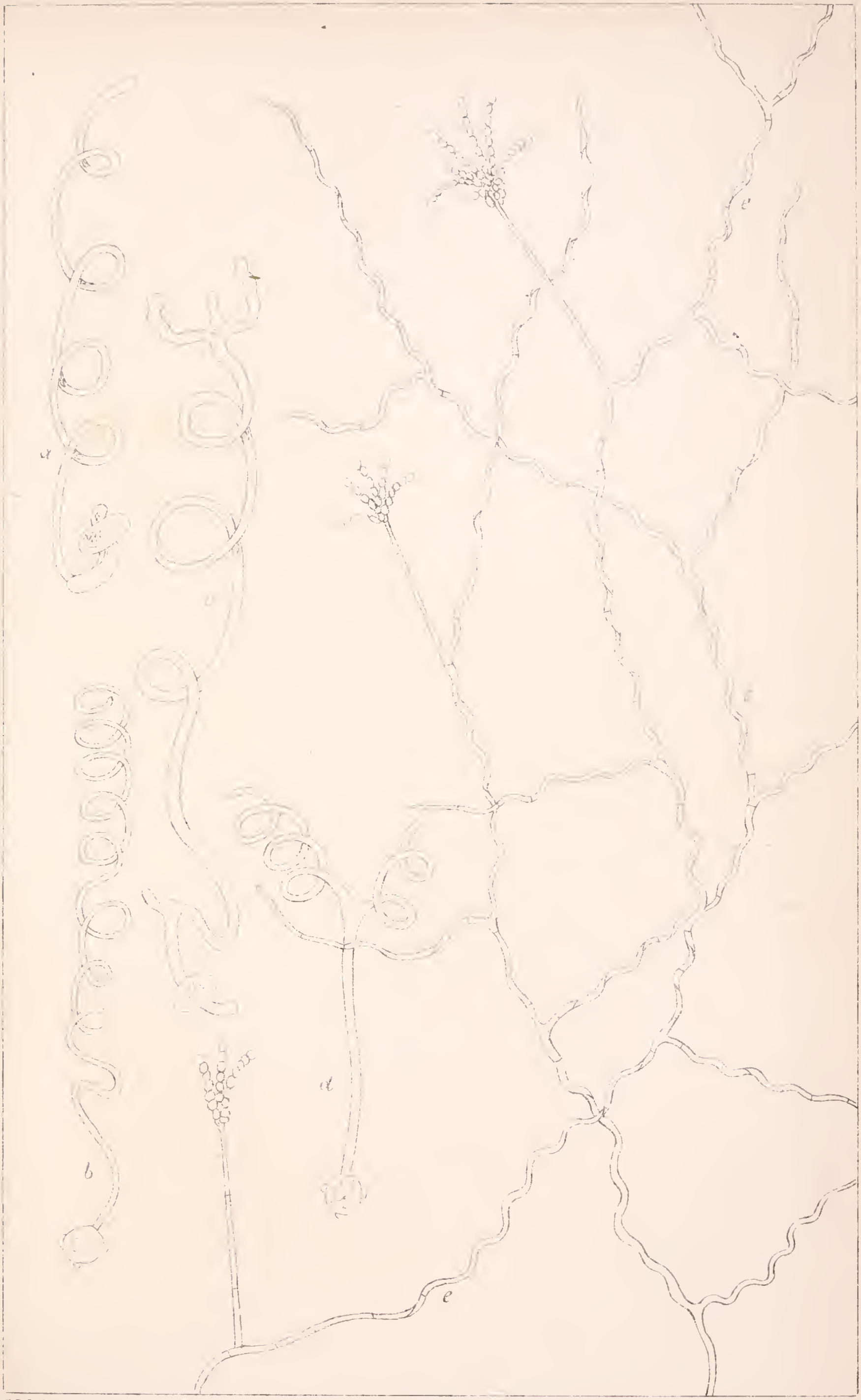
Members need not to be reminded that the late Dr. Charles Darwin demonstrated most elaborately in his works on "Climbing Plants" and the "Movements of Plants" certain movements so common in flowering plants, under various modifications, which he terms "circumnutation." This kind of movement has not been much observed, or, if observed not yet recorded, in the lower Cryptogamia, and yet it is an undoubted fact that such movements appear to be as general amongst the Cryptogamia as amongst the higher orders of plants. The conditions under which it has been observed hitberto is in the growing mycelium, or germinating threads which emanate from spores in favourable conditions, and these represent in miniature what ordinarily takes place in climbing plants, viz., a continual movement from side to side, forming a spiral round an imaginary axis, that highly developed form of circumnutation which is to be seen illustrated in the hop.

A writer in "Grevillea" * lately described this movement in the mycelioid threads of several of the Uredines, from which it is clear that he is of opinion, not that it was an exceptional case, but a constant phenomenon, which he failed to estimate at the importance it deserved. He says "when the spores of *Uredo linearis*, which are more or less ovoid in form, are sown upon a drop of water on a glass slide and placed under a bell glass, so arranged that the atmosphere within the bell glass is full of moisture, they very soon begin to germinate. As early as five hours and forty minutes they were found to have thrown out two germ tubes, one from each side of the long diameter of the spore near its centre. Sometimes only one tube was observed, but generally there were

* Vol. x, p. 136.

two. These tubes were hyaline and filled with very pale yellow endochrome from the interior of the spore, and were of uniform diameter, as nearly as possible, throughout their entire length. As a rule only one of these two twin tubes went on growing. When the major tube attained a length equal to several times the diameter of the spore from which it sprung, it took a series of spiral turns from right to left, or *vice versâ*. At this stage the tube presented a uniform diameter from end to end, but very soon the basal portion of it became enlarged and empty, and soon afterwards, at a short distance from the spore, a septum appeared which cut the empty base of the germ spore from the remainder. Before, however, this septum made its appearance, the abortive germ tube became quite empty, and the greater portion of the endochrome contained within the spore itself was transferred to the growing tube. The active tube continued making spiral turns upon itself like a corkscrew. The actual number of turns varied, as did their direction, whether from right to left, or left to right. Very often too, the tube would turn two or three times in one direction, and then reversing its movement, take a few turns in the opposite direction. The diameter too of the helix was subject to considerable variation. The sides of the tube were parallel to each other, and its diameter uniform. At the extreme end, which was blunt, there now appeared numerous irregularities which were incipient branches. Not infrequently the end of the tube trifurcated, in the manner of a trident. Usually one only of the main branches of the trident continued to grow, the others remained rudimentary. From this point all semblance of regularity in the contour of the tube was lost, and it gave off lateral branches somewhat after the manner of a stag's horn. The extremity of the tube did not even now lose its tendency to convolute, although this movement is considerably diminished. It is obvious that the spiral movements above described are of great importance to the fungus, as by them the growing mycelial tube has the chance of catching on any irregularity of the cuticle of the host plant greatly increased. This catching power is enhanced too by the trident-like terminal extremity with its irregular branched outline. Similar results to the above were obtained from watching the germination of the Uredo of *Coleosporium Tussilaginis*, of *Phragmidium mucronatum*, of *Uromyces appendiculata* and of *Æcidium crassum*."

Knowing the readiness with which some of the moulds germinate



M.C.C. del. A.H. Searle lith. Hanhart imp.

CIRCUMNUTATION IN FUNGI.

and produce a profuse mycelium, the above results set me to watch the germination of spores of the common mould *Penicillium glaucum*, and I had soon thirty or forty slides well covered with the germinating filaments of this mould, the growing points of the main shoots and branches circumnutating in a beautiful manner, forming spirals about ·012mm. in diameter, with six turns, or thereabout, to the one-tenth of a millimetre. Soon after germination the circumnutation commenced, branches were thrown off at intervals on either side, and these convoluted spirally in the same manner as the main thread. These branches seemed destined to steady, or hold the thread firmly, motion having ceased in the thread except near the extremities of the axis or its branchlets. Here and there short erect *straight* branches arose which bore at their apex the characteristic chains of spores. These did not exhibit any kind of perceptible motion and hence were not convoluted. All these examples were growing in a moist atmosphere, but not in water, the threads soon extended beyond the small drop of fluid in which they first germinated, and circumnutated in the air of the cell.

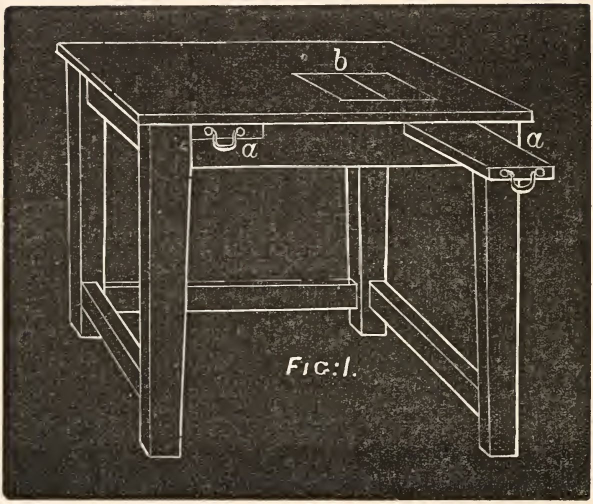
These results prove, therefore, incontestibly, that the spiral habit of the germinating threads of the spores is not a phenomenon confined to the *Uredines*, but is as active in the *Mucedines*, and probably in the majority of fungi, with some modifications, as in flowering plants. Hitherto my object has been simply to ascertain the fact of circumnutation, and hence no effort has been made to determine the direction of the spiral, the rate of growth, or of movement, or the influence of light, but I have no doubt that most interesting results would accrue from a systematic series of observations, such as those already made with climbing plants.

Plate IX. figs. *a* and *c* germinating spores of *Uredo linearis*; figs. *b* and *d* germinating spores of *Æcidium tussilaginis*, after Plowright; fig. *e* germ filaments of *Penicillium glaucum*.

Table for Microscopical Purposes.

By G. C. Karop, M.R.C.S.

(*Described September 28th*, 1883.)



Among all the paraphernalia of the microscopist, a suitable table seems about the last thing thought of. Any table appears good enough to stand a microscope upon, and although an astronomical amateur would never think of erecting his instrument on a ricketty base, photographers and others have special contrivances suited to their purpose, how often do we find on being invited to a microscopical evening our friend's instrument, perhaps a first-rater, set out on some unsteady drawing-room knick-knack with an ornamental bar between its supports on which we must not put our feet, while they will neither go comfortably under nor over it. Or else it is a round dining table with no room for the elbows, and out of all proportion to the height of the chair.

With the view of receiving further suggestions and criticisms rather than as putting forward any very novel idea, I beg to submit to the notice of members a form of table for use with the microscope

which I have found of practical value. It is simply a strongly made affair of the form represented in figure 1. I have no doubt someone will remark that it is only a kitchen table after all. But there is some little difference. In the first place its height must be proportional to the instrument in general use, and also to a comfortable chair. My own table is 2ft. 3in. from the top to the floor, which allows the microscope to be used in a vertical position without discomfort. The width is optional, mine is only 1ft. 6in. ; this is small, but suits my purpose. The length, too, is optional, except that it must not be less than 2ft. 9in., for reasons that will presently be seen. The legs should be stout and square, and made perfectly stiff by cross bars at the sides and back, the latter being put low down so as to serve as a foot-rest. The top is of soft white wood, free from knots and one inch thick, so that at any time it may be planed afresh if discoloured or eroded by acids ; of course, it must be quite level, and should project sufficiently in front to allow a section cutter being fixed thereto when required. There is no drawer, but on each side in front is a sliding board (*a*), to serve as an arm-rest either when observing or during manipulation. This is, so far as I know, a novel arrangement ; but be that as it may, it is an exceedingly convenient one, as the whole table is left clear for apparatus, material, reagents, &c., which need not be pushed to one side whenever recourse is had to the microscope, and, therefore, a comparatively small surface only is necessary. These arm-rests should be at least six inches wide and about 15 inches or more apart, sufficiently so, in fact, to admit the observer comfortably between them ; it follows, therefore, that the width of the table all over cannot be less than 2ft. 9in., and, of course, may be as much wider as may be thought desirable. To the right of the middle line on the top of the table it is a good plan to let in a piece of plate glass (*b*), about 7in. × 6in., level with the top, over a piece of good white paper or card. One half of the glass is blackened behind, and on the card opposite the transparent half is marked a 3 × 1 space with centering lines and a few of the more important microscopical measurements, such as the value of a micro-millemètre, the diameter of a red blood-corpuscle, &c., &c., and perhaps the magnifying power of the owner's objectives, or any other matters of constant reference.

PROCEEDINGS.

Friday, August 10th, 1883.—Conversational Meeting.

The following objects were exhibited :—

Section of Grass, stained and polarized ...	Mr. F. W. Andrew.
„ „ Tape Worm	Mr. W. I. Curties.
Head of Tree Spider, *Philodromus dispar*...	Mr. F. Enock.
Shell of young *Limneus stagnalis* ...	Mr. H. G. Glasspoole.
Parasite found on Earwig	Mr. G. E. Mainland.
Stephanogonia Danica	Mr. H. Morland.
Volvox globator, shewing fertilized oospores	Mr. G. Sturt.

Attendance—Members, 37 ; Visitors, 2.

August 24th, 1883.—Ordinary Meeting.

Dr. M. C. Cooke, M.A., A.L.S., President, in the Chair.

The minutes of the previous meeting were read and confirmed.

Mr. Henry Davis, and Mr. A. H. Searle, were balloted for and duly elected Members of the Club.

The following additions to the Library and Cabinet were announced :—

"Journal of the Royal Microscopical Society"	From the Society.
"Proceedings of the Bristol Natural History Society"	„ „
"Annual Report of the Bristol Natural History Society"	„ „
"Transactions of the Essex Field Club" ...	„ „
"Bulletin de la Société Belge de Microscopie"	„ „
"Science Gossip"	From the Publisher.
"Analyst"	„ „
"American Naturalist"...	In Exchange.
"American Monthly Microscopical Journal"...	„
"Quarterly Journal Microscopical Science"...	Purchased.
"Annals of Natural History"	„
"Grevillea"	„
"Microscopical News"	„
"Cole's Studies in Microscopical Science" ...	„

The thanks of the meeting were voted to the various donors.

The President remarked that as there was no paper for the meeting that evening, whilst the members were thinking over what they wished to speak about he would read a short paper which he had prepared.

He then read a paper on "Circumnutation in Fungi," and invited observations on the subject.

The President observed that Darwin had gone no lower than ferns in the vegetable scale for evidence of circumnutation. In order to observe the growth of the moulds which he had described it was only necessary to sow some spores in a drop of water contained in a cell, the cover being cemented down to keep in the moisture. On watching the cell for five or six hours the spores will be found germinating and thrusting the germinating thread through the water into the air. If the cell is not too deep the whole process may generally be seen on the cover glass. At first the germinating threads are thrust out straight, but after being pushed out about five or six times the diameter of the spore, by careful watching, the process of circumnutation may be seen to commence. that is, a circular movement going on, and, as in the hop-plant, feeling round in the air, as if seeking something to climb. The same movement takes place in the mould, as in the hop-plant, all the while turning round an imaginary axis; and as it vegetates within the cell the growing point continues to move round, circumnutating as it grows, at the same time lengthening out, while the motion ceases in the hinder part, which seems to be attached to the slide. The growing point alone keeps moving round, and the whole thread maintains a corkscrew form, just as the stem of the hop-plant coils round its supporting pole. He had some 30 to 40 slides, each containing 6 or 8 plants, in which everyone of the branches had taken this spiral form, and he hoped at some future gossip-night to bring up a few of the slides to show to the Members. He thought it probable that the same thing takes place in the growing point of many of the lower cryptogams. It was remarkable that, in such a simple plant as the common blue mould, there should be such an analogy to the hop.

Mr. Badcock thought that the subject was very suggestive and important. He enquired if the President could indicate the cause of the movement. He had observed something of the kind in studying pond life, and he wished to know the special object in view, and whether the tendency was not universal.

The President replied that if the movement was not universal it was far more common than was generally supposed. Movement in plants is as universal, though more limited, as movement in animals. Darwin has pointed out that in almost every plant he has examined some part of it moved. The plant being fixed by one point there is only one movement of which it is capable. Most plants had some movement, either regular or irregular, of this kind. As to the cause. He had no doubt there were several causes. First the influence of light. Plants that turned towards or from the light would circumnutate. Darwin divided circumnutation into three or four forms. Besides typical circumnutation there were also—1, an attraction towards the earth—*Geotropism.* 2, a turning towards the sun—*Heliotropism.* 3, a turning from the sun—*Aheliotropism.* There is no doubt that the hop-plant movement is one in search of something to which to attach itself, that is the primary intention of the move-

ment. The plant feeling out for something, taking a large sweep to go round the pole, and when it reaches the top, and can go no higher, the plant bends down, and it will reverse its course and try another direction to find something to grasp. Another thing is, there must be some influence which so far affected the cellular structure, and caused it to contract on one side and expand on the other. It must be so of necessity. The spiral must be shorter on the inside than on the outside. If the spiral could be unrolled the cells on the inside would be found more contracted than those on the outside. This was known to take place in the hop-plant, and, of course, served some good purpose in the life of the plant. These details of structure were not mere trifles, but something concerning the life and development of the plant.

The Secretary, in moving a vote of thanks to the President for his paper, remarked that it was part of his (the President's) work to trace the correlation between the life of plants and animals. Everything of that kind was very important. The vote was carried unanimously.

Mr. T. C. White called the attention of the Members to a larva which Mr. Parsons had brought, and was exhibiting under his microscope. It was a most curious creature, probably the larva of some Dipteron. Some years ago Mr. Parsons brought up a larva of *Limnobia*, which the present one somewhat resembled, but was of much more elaborate structure. Each segment of the body had a pair of eight branched processes which apparently carried on the respiratory system. It had six legs on the thorax, and six or eight very small compound legs like a caterpillar lower down. It was in constant motion, which made it difficult to examine, but it was a very interesting creature, and had commenced to spin a web in the cell in which it was confined. The *Limnobia* came from Snaresbrook: the present specimen was obtained at one of the Club excursions, but the exact locality was not known.

Mr. Parsons described some of the differences between the larva he had exhibited. In the *Limnobia* the tracheal system terminated in spines some simple and some branched. It had no legs, but managed to crawl about on the moss on which it fed. The head was retractile into the first segment of the body. There were two hooks at the anal extremity, the use of which he did not know, and it did not spin a web. In the present specimen the spines were divided several times, and there were very few simple ones. There were six legs on the anterior part of the body, and the compound legs had two rows of very beautiful hooks. Two of these legs were on the terminal segment or tail. The head was not retractile. The motion of the creature in spinning its web was curious. It lashed its body to and fro as if seeking for elbow room.

The President announced the meetings and excursions for the ensuing month, and the meeting closed with the usual conversazione, at which the following objects were exhibited :—

Tentacles of Barnacle	Mr. F. W. Andrew.
Plumularia setacea, mounted with extended Polyps	Mr. C. G. Dunning.

Gamasus sp., with hooked spines on second pair of legs	Mr. H. E. Freeman.
Larva of Fly (alive)	Mr. F. A. Parsons.
Calcareous Skeletons of *Madrepores* (Recent) from Ilfracombe	Mr. H. J. Waddington.

Attendance—Members, 37 ; Visitor, 1.

SEPTEMBER 14TH, 1883.—CONVERSATIONAL MEETING.

The following objects were exhibited :—

Seeds of *Campanula*	Mr. F. W. Andrew.
Hair of Fox	Mr. A. Button.
Lacinularia Socialis	Mr. E. Dadswell.
Campanularia flexuosa, with Polyps extended	Mr. C. G. Dunning.
Leg of Honey Bee, showing Pollen basket and combs for cleaning the body ...	Mr. F. Enock.
Acarus from Bat, *Myobia*	Mr. H. E. Freeman.
Difflugia Proteiformis	Mr. W. Goodwin.
Penis of Child æt. 8 months, transverse section	Mr. G. C. Karop.
Diatoms from Chincha Guano, *Syndendrium diadema*, *Dicladia capreolus*, *Chætoceros didymum*, &c., &c.	Mr H. Morland.
Nests of *Lima hians* dredged in the Clyde off Cumbrae	Mr. S. H. Needham.
Sertularia pumila, with Polyps expanded ...	Mr. G. Sturt.
Sand siftings from Tenby	Mr. W. M. Young.

Attendance—Members, 47 ; Visitors, 5.

SEPTEMBER 28TH, 1883.—ORDINARY MEETING.

DR. M. C. COOKE, M.A., A.L.S., President, in the Chair.

The minutes of the preceding meeting were read and confirmed.

Mr. A. J. Western was balloted for and duly elected a member of the Club.

The following additions to the Library were announced :—

"Proceedings of the Royal Society"	From the Society.
"Science Gossip"	„ the Publisher.
"The American Naturalist"	„ the Editor.
"The American Monthly Microscopical Journal"	„ „

"Bibliotheca Zoologica"	From the President.
"Bibliotheca Entomologica," Vol. I.	" "
"Annals of Natural History"	Purchased.
Vol. VIII. "Challenger Reports"	"
Publications of the Linnæan Society, from Oct., 1873 to May, 1883	From Mr. Scofield.

The thanks of the Club were voted to the donors.

The President announced that the Committee had that evening resolved to repeat the experiment of last year, by arranging to have a series of six demonstrations on the Gossip nights during the coming winter, commencing in December and ending in May. They would be held at the same place and hour as on former occasions, and it was contemplated to include amongst the subjects some of the more elementary matters which were likely to be useful to the younger members of the Club. The subjects to be treated had not yet been definitely decided upon, but it had been thought that it might increase the interest of these occasions if members would indicate the line of subject they would most desire to have, and he therefore invited members to suggest such topics as they might have in their minds. The number of demonstrations was limited to six, but in the event of the subjects suggested exceeding that number, the Committee would select from the list such as were deemed of most practical value, their desire being to ascertain from the members themselves upon what branches of microscopy information and instruction were specially wanted.

Mr. W. D. Smith exhibited and described a new modification of a turntable. This turntable laid no claim to originality, being nothing more than an attempt to unite, in one piece of apparatus, the various points that seemed to be most valuable in Kinné's instrument, and in that invented by Mr. Dunning, and described at page 81, Vol. vi. of the Journal. It consisted of a circular brass plate, on the under side of which was a lever, having its fulcrum on the axle of the table. This lever moved two arms which worked in slots cut in the plate, so that they always approached or receded from the centre in an exactly equal degree. The arms carried on the upper side of the plate two flat pieces of brass, two inches in length, which grasped the slide, one of these being fixed at right angles to the slot, and the other pivoted so as to be able to adjust itself to the slide, as in Mr. Dunning's instrument.

Mr. Ingpen said the members would be pleased to know that he had received a further communication from Dr. Whittell, of Adelaide, in proof that he did not forget his association with them.

The President announced the forthcoming soireés of the Highbury Microscopical Society, and of the South London Club, and invited the assistance of members of the Q. M. C. on those occasions.

Mr. G. C. Karop gave a short description, which will be found on another page, of a microscope table he had had constructed, and found very convenient for the purposes it was intended for.

Mr. T. C. White said he had no practical experience in table-turning, but

he had turned one into a microscope table, and found it answer very well, though he did little more than cut down the legs and make it stand firmly at the proper height to use comfortably. The first requirement was that a table should be sound and firm, those which revolved were not satisfactory on account of being so very unsteady. Nothing to his mind was better than the good old kitchen table form.

Mr. Karop said the top ought to be at least an inch thick when planed down, and he had found 2ft. 9in. × 1ft. 6in. amply large enough for all purposes.

The Rev. H. J. Fase thought that Mr. White, in his large experience had forgotten a very convenient form which he remembered to have seen at his house some years ago. It was a kind of revolving desk which was simply placed upon an ordinary dining table.

Mr. White said that he had found the contrivance referred to by Mr. Fase a very useful thing when one had a friend to whom it was desired to show objects under the microscope, and it was certainly very much better than a revolving table. It was made out of a piece of mahogany 16 inches square to which was fixed a heavy leaden foot, and some small castors on which it would turn freely when stood on an ordinary table. It was quite large enough to hold the lamp as well as the instrument, and could be passed or turned round to anyone else without altering their relative positions.

Mr. Ingpen said that the old device of a revolving table was very useful if only it could be made steady. With regard to the question of vibration, he remembered that there was an article in their Journal some years ago by Mr. Bridgeman, of Norwich, in which he proposed to get rid of vibrations by using two boards separated by indiarubber rings, and connected together by strong indiarubber bands, the idea being that the cross vibrations allowed by the indiarubber neutralized others. In working with high powers the vibrations troubled him so much that he thought of mounting the microscope on a column isolated from the floor, after the manner of a transit instrument.

Dr. Matthews said there was another form of revolving table which was simple and effective. It consisted merely of two boards clamped and planed so as not to be liable to warp; the size should be about 16 inches square by ½-inch thick, pivoted together in the centre without being actually fastened to each other, so that the top one would turn freely upon the one underneath. The best annuller of vibration was simply a quire of blotting-paper clamped to the edge of the board; by this means all vibration was reduced to the smallest possible degree. It was also of advantage to put under the boards a piece of soft indiarubber, which served the purpose of green baize, and acted like the blotting-paper in reducing vibrations. This plan was much better than the table referred to by Mr. Ingpen, and he could strongly recommend it.

Mr. Ingpen said he should not have omitted to mention that a great deal depended upon the character of the microscope as to the kind of vibrations which would affect it. Some time ago a paper on the subject was written by Dr. Carpenter, who narrated his experiences of working with several

forms of microscopes on board ship If they had the bodies separated on the Jackson-Lister arm they would have the objective eyepiece and object supported on the same part, and all would vibrate together. In the Ross model the communication was down a long arm and a triangular bar and back again. In the Powell and Leland pattern there was a certain arrangement of small springs which got rid of vibration almost entirely, but in all the smaller instruments there was a difficulty, and it made all the difference which of the two models they had—the Jackson-Lister or the Ross. Vibrations communicated equally were less trouble than those communicated unequally. This struck Dr. Carpenter, and it was certainly a point of importance for consideration in the original selection of a microscope.

Votes of thanks to Mr. Smith for his communication, and to Mr. Karop for introducing the subject for discussion, were passed, and the announcements of meeting, &c., for the ensuing month having been made, the proceedings terminated with the usual conversazione, at which the following objects were exhibited:—

Anthers and pistil of Dahlia, with pollen tubes.	Mr. F. W. Andrew.
Acari, *Dermaleichus*, from Red-tailed Boatswain	Mr. C. G. Dunning.
Reflexed saws of *Trichiosoma lucorum* ...	Mr. F. Enock.
Acarus, *Molgus*, found in hay	Mr. H. E. Freeman.
Section of Footpad of Elephant, polarized ...	Mr. T. S. Morten.
Aphis, from Myrtle	Mr. J. Avelard.
Eggs of Parasite of Rhinoceros Hornbill ...	Mr. C. Le Pelley.
Young Anemone, *Sagartia bellis*	Mr. H. J. Waddington.

Attendance—Members, 55; Visitor, 1.

October 12th, 1883.—Conversational Meeting.

The following objects were exhibited:—

Eggs of Silk Moth with larva emerging ...	Mr. F. W. Andrew.
Young Sponge (*Grantia ciliata*) on marine alga (*Wrangelia multifolia*)	Mr. T. W. Buffham.
Sand from Desert between Moses' Well and Suez, rounded and polished by friction	Mr. A. Button.
Drosera rotundifolia, alive, feeding on a fly	Mr. W. I. Curties.
Acari, *Glyciphagus spinipes* ... ,, *Cheyletus Venustissimus*, alive, and mounted	Mr. H. E. Freeman.
Sections of Australian Woods, cut with a plane	Mr. H. G. Glasspoole.
Hamatopinus Suis	Mr. H. R. Gregory.

Avanturine-Felspar (Sunstone) from Norway	Mr. H. Hensoldt.
Stentor Mulleri	Mr. C. Le Pelley.
Saprolegnia with sporangia	Mr. G. E. Mainland.
Diatoma grande	Mr. H. Morland.
Internal Parasite of Cod fish	Mr. T. S. Morten.
Acarus	Mr. J. A. Ollard.
Statoblasts of various fresh water sponges, also of *Cristatella mucedo*, shewing the similarity between them	Mr. B. W. Priest.
Reedia Glaucesca. The flower decoloured	Mr. A. W. Stokes.
Diatomaceæ, *Asteromphalus Humboldtii*, &c., San Fernando	Mr. G. Sturt.
Perforating Alga, or Fungus, from Sand deposits at the mouth of the Thames	Mr. J. G. Waller.

Attendance—Members, 57; Visitors, 1.

October 26th, 1883.—Ordinary Meeting.

Dr. M. C. Cooke, M.A., A.L.S., President, in the Chair.

The minutes of the preceding meeting were read and confirmed.

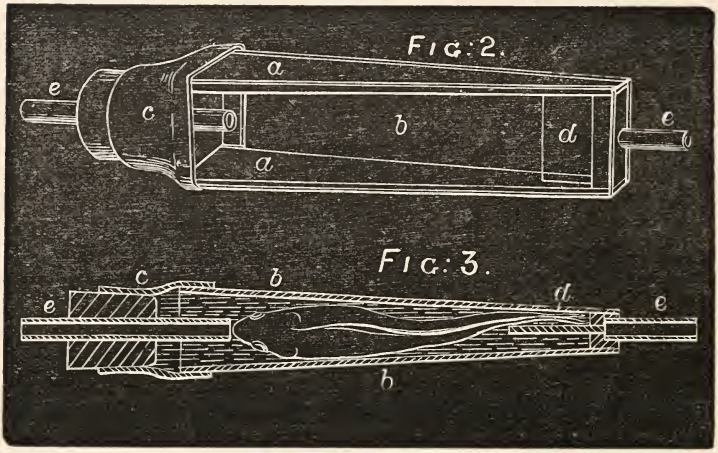
The following gentlemen were balloted for and duly elected members of the Club:—Mr. Charles J. Addiscott, Mr. George Fleetwood.

The following Donations to the Club were announced:—

"Journal of the Royal Microscopical Society"	From the Society.
"Twelfth Report of South London Microscopical Society"	" "
"Sixth Report of Hackney Microscopical Society"	" "
"Report and Transactions of the Birmingham Microscopical Society" ...	" "
"Journal of the Postal Microscopical Society"	" "
"Science Gossip"	From the Publisher.
"The American Naturalist"	In exchange.
"Annals of Natural History"	Purchased.
"Fresh Water Algæ," part 6	"
"Coles' Studies in Microscopy"	"
2 Slides	From Mr. Freeman.

The thanks of the Club were voted to the donors.

Mr. Stokes exhibited and described a simple apparatus for aërating living fish whilst under microscopical observation.



This apparatus is shown in perspective view at Fig. 2, Fig. 3 being a longitudinal section. In these figures *a*, *a*, are two wedge-shaped slips of wood, well soaked in paraffine wax to render them waterproof. *b*, *b*, are two 3 × 1 glass slips, which are so arranged as to form, with the wood slips a wedge-shaped glass box.

The larger end of this box is enclosed in a short piece of indiarubber tube, *c*, and this tube is closed by a cork.

A short piece of glass, *d*, is fixed inside about midway between the glass sides of the box, so that it will form a shelf upon which the fishes tail may lie during examination, as shewn in fig. 3.

At either end of the box are fitted two short glass tubes, *e*, *e*, which when the instrument is in use are respectively connected by indiarubber pipes with two bottles. One of these bottles is to be placed on the table below the level of the microscope stage, and the other—filled with water—a little above the level of the stage. The water will then trickle down from the upper bottle, through the wedge-shaped box into the lower bottle, and when the latter is full the position of the bottles may be reversed, and in this way a constant circulation kept up for any length of time.

Dr. Matthews said that some few years ago he exhibited a live slide on the same principle as that shown by Mr. Stokes. It was not his own idea, but was an article imported from America by Mr. Beck. It consisted of a thick piece of glass excavated in some way, and had a piece of small pipe inserted in each end; it was perfectly true on its surfaces, and when used it was only necessary to cover it over with a thin piece of plate glass. It answered the purpose admirably, so that he was able to use the same fish eight or nine times.

Dr. G. D. Brown said that having seen the slide he could say that it seemed to him to be a very admirable contrivance for the purpose.

Referring to the discussion which took place at the last meeting with respect to microscope tables, Mr. Mainland suggested that the best substitute for a revolving table was one of the highly lacquered Japanese trays now so common in this country, recommending that one should be chosen for the purpose, about 20in. × 12in., as flat and true as possible. The microscope, lamp, &c., might be placed upon this, and being adjusted could be passed along the table with the greatest ease. The advantage of this plan was that the microscope was raised as little as possible above the table, whilst the rim of the tray served the double purpose of affording something to take hold of and keeping the accessories from getting swept off the surface.

Mr. J. D. Hardy said he could speak from experience as to the efficacy of the tray, having used one for the purpose for the last five years. It was a very simple and efficacious means of keeping all one's things together, and was very easily passed over the table cloth. For ordinary work it was everything required.

Mr. J. A. Ollard exhibited a simple form of revolving table which he had made out of two mincing boards.

Votes of thanks to Mr. Stokes, Mr. Moreland, and Mr. Ollard, for their communications were unanimously passed.

Mr. A. D. Michael said that some time ago he had a concave mirror constructed of opal glass, and found that whilst it answered the purpose of giving clear definition there was a considerable loss of light. In endeavouring to account for this it occurred to him that it might be due to some of the light being more or less polarized. In order to test this he put on the analyser, and was rather surprised to find how efficiently the light was polarized. They were well aware, no doubt, that light could be polarized in various ways, such as with a Nicol prism, or by reflection at a particular angle, or by passing it through thin plates of glass set a similar angle. He, therefore, thought that he must have got his microscope inclined at just the polarizing angle, but on altering it the effect did not go off as he had expected, and in fact he found that he got polarized light at almost any angle. The effect was just the same if he substituted for the mirror a piece of white china or a white dinner plate, and the first question which occurred to him was, why was light polarized in this way by reflection from some substances and not from others? His microscope was in the room with an analyser upon it, and being adjusted at haphazard they would be able to see for themselves what he had described. It might be asked *cui bono?* and perhaps there was not much good in it, though a full field of light was obtained. He did not claim any speciality, but thought the matter was sufficiently interesting to warrant him in bringing it before the meeting.

Mr. Stokes enquired if more light was obtained in this way than with a prism?

Mr. Michael said this was the case.

Mr. C. Stewart asked if the blackness of field was equal to that obtained

by the use of two prisms, as one would think that a large amount of ordinary light would be mixed with it?

Mr. Michael could not say if this was so, but should have thought that the polarizing effects would have been less vivid if the light had been so mixed.

Mr. Goodwin enquired if there was any difference in the intensity of the polarization at different angles?

Mr. Michael said that as long as the quantity of light was the same the effects appeared to be the same also.

Dr. Matthews said he saw the effects described by Mr. Michael for the first time on the previous evening, and could testify to the complete success of the experiment. He has since that time consulted a number of authorities upon the subject, but could not find out that any of them had mentioned having noticed anything of the kind. He thought the discovery was one well worthy of attention.

Mr. Ingpen asked if part of the effect might not be due to the mirror being concave instead of flat?

Mr. Michael thought it could not be due either to flatness or concavity because light reflected from a flat plate or a concave saucer appeared to answer equally well; in fact, a sheet of glazed paper did the same, only there was less light reflected from it.

Mr. Stewart thought it was probably a question of surface reflection, and not from the interior.

Mr. Ingpen said if it was a question of glass surface reflection then angle would be of importance.

Mr. Buffham thought the probability was that it was in the nature of the reflecting substance that it could not be figured and polished so accurately as ordinary glass, and that the effects produced were purely due to surface action. They might thus get a figure which, though apparently regular, really was not so, but exhibited thousands of little facets lying at all possible angles, numbers of which would be sure to lie at the polarizing angle. He was not aware that there was any special polarizing power in the material employed, but his idea was certainly that the effects could be accounted for solely in the way he had suggested.

Mr. Hardy enquired if the glass reflector was opal throughout, or only on the surface?

Mr. Michael said it was opal all through.

The thanks of the meeting were voted to Mr. Michael for bringing forward this interesting and practical subject.

Mr. E. M. Nelson said that there had no doubt been a great many improvements made of late years in the microscope, and there had been some very extraordinary things produced. As regarded lenses, he believed the move had been in the right direction, but as to some other things, what with arcs, and joints, and verniers, and goodness knew what, was it a move in the right direction at all? For his own part, he inclined to think that the instrument had retrograded in consequence of the effusiveness of energy displayed in these directions. All these swinging substages, and

things of that sort were introduced for the purpose of resolving difficult diatoms; but did they really do it better than anything else? He thought not. He then drew upon the blackboard a diagram of what he styled "the last thing out," explaining the advantages claimed for it, but expressing an opinion that such contrivances, so far from being advantageous, merely tended to complicate and to introduce errors. He had brought for exhibition two slides of *Amphipleura pellucida*, for exhibition in the room, and though one was Van Heurck's, placed on a Powell's instrument, with $\frac{1}{12}$ objective, and the other a dry mounted specimen, he ventured to say, they would find that the one shown dry, with inferior apparatus, gave the better effect; both instruments being set to the best pitch of resolution.

The President then announced the meetings, &c., for the ensuing month, and the meeting concluded with the usual conversazione, at which the following objects were exhibited:—

Spirorbis nautiloides	Mr. F. W. Andrew.
Marine Mite *Halacarus notops*...	Mr. H. E. Freeman.
Vinegar Eels, alive	Mr. G. Hind.
Fredericella Sultana	Mr. C. Le Pelley.
Argulus foliaceus from Stickleback	Mr F. J. McManis.
A polariscope in which the polariser is a mirror of opal glass	Mr. A. D. Michael.
Amphipleura pellucida in Van Heurck's medium, $\frac{1}{12}$ oil immersion objective and C eye-piece × 1,200. *Amphipleura pellucida*, dry, $\frac{1}{25}$ oil immersion objective, and A eye-piece × 1,250, illustrating paper read by him	Mr. E. M. Nelson.
Lophopus crystallinus and *Fredericella Sultana*	Mr. C. Rousselet.
Circulation in the tail of a minnow, shown in the apparatus described by him ...	Mr. A. W. Stokes.
Diatoms *Entogonia punctulata* (Grev.) Cambridge, Barbadoes	Mr. Gerald Sturt.
Membranipora, alive	Mr. G. Western.

Attendance—Members, 28; Visitors, 4.

November 9th, 1883.—Conversational Meeting.

The following objects were exhibited:—

Floscularia cornuta	Mr. F. W. Andrew.
Tetraspores in ramuli, on *Polysiphonia byssoides*	Mr. T. H. Buffham.
Native Gold, Australia	Mr. E. Carr.
Diatoms from Cuxhaven	Mr. W. I. Curties.
Möller's Test Plate, 60 species of Diatoms mounted in Monobromide of Napthalin	Mr. T. Curties.
Spirorbis nautiloides	Mr. H. Epps.
Acarus. *Glyciphagus*, sp.	Mr. H. E. Freeman.
Section of *Banksia*, showing medullary cells	Mr. H. G. Glasspoole.
Nitzschia amphioxys	Mr. H. Morland.
Thusaria thuga, with vessicles...	Mr. J. A. Ollard.
Medusoid form of *Campanularia*	Mr. F. A. Parsons.
Pycnogon, sp.	" "
Sponge. *Myerina claviformis*...	Mr. B. W. Priest.
Shells of young of *Limneus stagnalis*, polarized	Mr. A. W. Stokes.
Crystals of Magnesium urate	Mr. H. J. Waddington.

Attendance—Members, 52; Visitors, 3.

November 23rd, 1883.—Ordinary Meeting.

Dr. M. C. Cooke, M.A., A.L.S., President, in the Chair.

The minutes of the preceding meeting were read and confirmed.

The following gentlemen were balloted for and duly elected members of the Club:—Mr. E. Bostock, Mr. Martin C. Cole, and Mr. Thomas Plowman, jun.

The following donations to the Club were announced:—

"Proceedings of the Hertfordshire Natural History Society"	From the Society
"Proceedings of the Geologists' Association...	" the Association.
" " Glasgow Natural History Society"	" the Society.
"Proceedings of the Belgian Microscopical Society"	" the Society.
"The American Monthly Microscopical Journal"	In exchange.
"Science Gossip"	From the Editor.
"Annals of Natural History"	Purchased.
"Quarterly Journal of Microscopical Science"	
"Report of the Smithsonian Society" ...	From the Society.

Cole's "Studies"	Purchased.
"Zellbildung und Zellthutung" ...	From Mr. W. H. Gilburt.

A vote of thanks to the donors was unanimously passed.

A list of books purchased by the Committee for addition to the Library was read.

The President said that he had to report to the Club the death of one of their members, which had occurred since their last meeting, a member who, during his lifetime, had exercised a considerable influence in perfecting the instrument with which they worked. He alluded to the death of Mr. Hugh Powell, of the well-known firm of Powell and Lealand. The announcement would be received with considerable regret, although it could not be said to be quite unexpected, for having reached his fourscore years and four, it could not be said that his time had been short. What Mr. Powell had done in the perfecting the instrumental parts of the microscope would probably be estimated even more highly in the future than at the present time.

Mr. Ingpen said he should perhaps be excused for adding to what the President had said, a few words expressive of the great estimation in which he had held the late Mr. Powell. He had known him—not perhaps intimately—but in his scientific capacity, ever since he (the speaker) was a boy, and he recollected him as a regular attendant at the early meetings of what was then the Microscopical Society of London. From the first time of his official connection with the Club, he always had from Mr. Powell his most cordial recognition and sympathy in their work, and he invariably attended and exhibited at their soireés as long as there were any to come to. He felt that he could not let the occasion pass without paying his personal tribute to one to whom microscopy, not only in England, but he might say all over the world, owed so much.

Mr. Stokes exhibited and described a portable lamp for the microscope, the base of which was made of several rings sliding one within the other, like the joints of a telescope tube.

Mr. G. C. Karop said, members who had much to do with cutting sections of animal tissues were fully alive to the disadvantages of the ordinary imbedding agents, such as paraffin mixtures, wax and oil, &c. In the first place they are messy to work with, secondly, they are difficult to make of the proper consistence, too soft in summer and too hard in winter ; very apt also to shrink away from the specimen or well of the microtome on cooling, and lastly, the greasy material often adheres most obstinately to the section, particularly if this be of irregular outline. There has lately been introduced a form of pyroxylin known as Schering's patent celloidin, used by photographers for making a uniform quality of collodion. It is in the form of flat cakes of extremely tough, horny consistence, and said to be non-explosive, burning like paper, and simply carbonising if heated in a test-tube. The method of using this material as an imbedding agent is as follows:—A sufficient quantity is cut up and dissolved in equal parts of absolute alcohol and absolute methylated ether ·717, until the solution is just thin enough to pour. This takes some time, and the mixture should be well stirred daily,

and kept in a warm room. The mass to be cut is hardened in any desired manner, and fastened by needles in the requisite position for cutting in a paper case the same size as the well of the microtome. The celloidin solution is poured in as free from bubbles as possible, and allowed to set slightly. The paper case and its contents is then placed in a quantity of methylated alcohol of 80°, not less, as otherwise the celloidin becomes tough, and not more, or it will dissolve it. It is left in this until of the proper consistence to cut, about as firm as boiled egg albumen. If possible the sections should be cut under the surface of methylated spirit, Katsch's machine is made for, and is simply perfect for this purpose, but sections can be cut very well if the whole surface of the microtome in use is kept flooded with spirit. The sections can be stained by any of the ordinary fluids, the celloidin takes a slight stain, but as it is perfectly amorphous it does not in any way interfere, and can, of course, if the species of section admit it, be dissolved away by the mixture of ether and alcohol. On the whole it seemed about the best thing for the purpose that he had met with, and members might judge of its fitness by the fact that it enabled one to cut sections of the whole eye, every structure remaining *in situ*, a feat he supposed impossible with any other material. Celloidin might be obtained from Messrs. A. and M. Zimmerman, 21, Mincing Lane, E.C., price 2s. 3d. per cake.

The Rev. H. J. Fase thought that the lamp which was exhibited by Mr. Stokes might be improved if the stand was made oval instead of round, and if made of thin stamped brass it would be very much lighter, and perhaps less expensive to make.

Mr. Stokes said of course the lamp did not pretend to be perfect, but he thought the objection to an oval shape was the difficulty of making the joints fit tightly. With a round tube the sections could be turned round in any position, and would always work smoothly, but an oval one could only slide up and down in one position, and would very soon get worn smooth and loose.

Mr. T. Curties exhibited a set of apparatus for collecting microscopic *materiel*, devised by Mr. Aylward of Manchester, consisting of a japanned tin case containing three large sized glass tubes, part of the case forming a strainer for draining off superfluous water; another case, containing six large tubes; a third case, containing three bottles; and a fourth with four long tubes of smaller diameter. In addition to these there was a clip for holding the tubes, and securing them to the end of any walking stick by an ingeniously contrived tapering spiral wire; whilst a cutting hook for detaching and obtaining portions of pond weeds was designed to be fitted in a similar manner.

The thanks of the meeting were voted to Mr. Karop, Mr. Stokes, and Mr. Curties for their communications.

Mr. E. M. Nelson called attention to some observations which he had made on Spermatozoa, and pointed out, by means of drawings on the black board, that the doubts which had been expressed as to the form of the filament of the spermatozoon of the Newt, had been set at rest by the dis-

covery that the appearance was really due to the waved outline of a dorsal appendage. He also drew on the board the figure of a human spermatozoon, showing a remarkable "nick," which, on examination with the highest powers, he had found to be always present a short distance from the commencement of the tail.

Mr. Karop thought it just possible that though this was seen in mounted specimens it might not be present in fresh living specimens.

Mr. Stokes inquired if it showed in specimens which had been wetted and then dried again?

Mr. Nelson said the specimens examined had been either dry or mounted in glycerine; he had not seen any stained specimens.

Mr. Curties said it was so common for slides of these objects to be distributed mounted dry that he was surprised that the observation had not been made before.

Mr. Karop said that anyone who had the opportunity of double staining would find a very good object in the testicle of the newt; sections of which might be prepared with methyl green and logwood—the methyl green had a special affinity for the heads of the Spermatozoa, and showed them very plainly *in situ.*

The President said that some enquiries were made occasionally for large winged seeds for mounting; he had therefore brought some specimens of the seeds of *Bignonia Indica,* the wings of which showed structure under the microscope. The specimens were placed upon the table for distribution.

Announcements of meetings, &c., were then made, and the meeting terminated with the usual conversazione, when the following objects were exhibited:—

Cordylopora lacustris	Mr. F. W. Andrew.
Dichroic Crystals of Platino-cyanide of Yttrium	Mr. H. R. Gregory.
Stephanocerus Eichhornii and *Vorticellæ* ...	Mr. W. Hainworth.
Dermanyssus avium (Bird Mite)	Mr. Mainland.
Living Nymphs of *Tegeocranus latus*	Mr. A. D. Michael.
Young Spider (*Epiera diadema*)	Mr. J. Offord.
Horned Aphis (*Cerataphis lantariæ*)	Mr. F. A. Parsons.
Piterite—Gümbelberg, Moravia	Mr. G. Smith.
Syenite—Malvern Hill	"
Diatoms (*Actinoptychus pellucidus*)	Mr. G. Sturt.

Attendance—Members, 67; Visitors, 4.

December 14th, 1883.—Conversational Meeting.

The first demonstration of the second series was given by Mr. T. Charters White, M.R.C.S., L.D.S., &c.; the subject being the method of preparing sections of hard tissues.

Mr. White prefaced his demonstration by saying, "These demonstrations have very properly been instituted by the Quekett Microscopical Club for the purpose of carrying out the educational programme laid down by its founders in which it was intimated that "each member would be solicited to bring his own individual experience, be it ever so small, and cast it into the treasury for the general good,"—they are addressed therefore, especially to the tyro, and are intended to aid our younger members, not the more accomplished microscopist; they partake of a more elementary character than if they were for the benefit of the veterans. One of the first things which engages the attention of the young microscopist (by whom I mean a person of any age who has just procured a microscope), is the examination of the *outside* of various substances within convenient reach. Having satisfied his curiosity by a superficial inspection of such easy things as bread, sugar, potatoes, &c., his next desire is to see the *inside* of the many subjects which present themselves to his notice, and for this purpose he desires to make sections of them. The subject I have chosen for the demonstration of this evening is therefore one likely to interest the young beginner, and few things are more instructive than an examination of such hard tissues as bone, teeth, or shell. Those who had the pleasure of hearing Mr. Grove's demonstration last session on soft sections, derived also the profit of seeing how these beautiful sections are made and mounted, and although there is a great difference in the care and delicacy required to produce good sections of the animal tissues, yet the principles and practice laid down in that demonstration can be acted upon in the production of many, if not all of the soft vegetable tissues, and therefore any consideration of these may be omitted from my demonstration this evening. I hope that my brief remarks and such manipulation as I can lay before you in the time allotted to me may induce many of my younger brother members to make sections of the hard tissues for themselves. This subject has been very well treated of in most of the Text books on Microscopic Technology, and for fuller information I may refer you to "The Preparation and Mounting of Microscopic Objects," by Thos. Davis, page 146, and "Microscopic Dictionary," article "Preparation," p. 632. The plan recommended by most of the authorities is as follows: With a spring saw, such as I have here, saw as thin a section of the hard tissue as you can, polish one side of it and cementing that side to a piece of glass, rub the other side on a hone till it is thin enough to see the details of its inner structure well defined, dissolve it off the piece of glass, and after well cleansing it from *débris* mount it permanently in balsam. This plan no doubt is a good one, and capable of producing very

excellent results, but I have found it attended by two drawbacks, 1st, the enamel of the teeth was so hard that it soon wore out all the serrations of my saw, and it also took a long time to cut the section. The next drawback to this plan was, that however carefully the section was prepared when it came to the process of being dissolved off the glass in spirit preparatory to mounting, the spirit carried the balsam into the structure, and obliterated all its detail, if not at the time, certainly at some time after. I got over these difficulties in this manner: Having plenty of materials at my disposal I contented myself by making one section out of each tooth, grinding the side of the tooth against a corundum wheel in a dentist's lathe, sticking the ground side on to a piece of glass with very hard balsam, and then grinding the other side in a similar manner till the section was moderately thin. I then detached it from the glass and putting the section between two plates of ground glass, I rubbed it with the aid of finely-powdered pumice stone and water till I got it of the required thinness—it was necessary to examine it from time to time under the microscope in order to avoid cutting it too thin, for I have rubbed sections so thin that with one turn more of the upper plate of ground glass I have caused the section to disappear altogether. I think, therefore, it is desirable to urge this precaution on your attention. The plan I have described not only ensures perfect parallelism between the two surfaces of the section, but also allows of your getting it much thinner than the plan usually recommended, and it has this further advantage to recommend it, which leads me to the method by which I overcome my second difficulty, viz., the balsam running in and obliterating the structure. After I have got the section as thin as I wish I cleanse it thoroughly from the *débris* it has acquired in the grinding, and put it away in distilled water until I require to mount it in balsam. I then take it out of the distilled water, dry its surfaces by wiping them with a warm and clean finger, and then mount in cold balsam; the internal structure whether lacunæ, canaliculi, or dentinal tubules are occluded by the distilled water, and the balsam is prevented from running in. I have, however, lately received the details of a plan from Mr. Ady which will, I imagine, entirely surpass the method I have described, but as I have had no experience in its working, I will ask Mr. Ady, who is present, to give some detail of his plan.

" The making of bone sections is carried out in the same way as that of teeth, but it is much easier, owing to the absence of the hard enamel. The same plan may also be adopted for making sections of shell, the stones of fruit, and cocoa-nut shell. Sections of Echinus spines are difficult to make on account of their brittleness, but if they are soaked in a solution of hard balsam in benzol, and then dried, they can with care, be reduced to very thin sections without fracture.

" For this purpose I should prefer to use some of the older pieces of ground glass, such as have by use become partly polished, as there is then no drag of the grain against the brittle cells of the spine. This same plan may also be adopted for making sections of the entire jaw of small animals,

such as the mole, mouse, weasel, &c., where it is desired to examine the teeth *in situ*, and to study them in connection with their alveolar sockets. Sections of rocks can only be cut with a lapidary's wheel, and I have had no experience with that apparatus. Sectons of coal I have tried, but the process is so dirty, that I think it is better to buy them ready made than get begrimed in making them for myself; I have tried the process of letting the coal soak in a saturated solution of corbonate of potash, but have not succeeded in getting it soft enough to cut with a razor. Very good sections of wood maybe obtained from any cabinet-maker's workshop, from the planings of various woods used by him in his work, selected pieces of the shavings mounted in balsam, make very instructive objects, and many of them will polarise very beautifully."

Mr. White then proceeded to demonstrate practically his method of grinding down a section of tooth, first on a corundum wheel, and afterwards with ground glass slabs of varying degrees of fineness. He then called upon Mr. Ady, who explained what he termed "the laccic" method of occlusion, substantially as follows:—

1st. Saw a piece off the tooth or bone, rub it flat on an engineer's file, polish the flat surface on a fine hone, water of Ayr stone being preferable.

2nd. Fasten the section on to a piece of plate glass, one inch square, with a cement made by melting six parts of "button" lac with one part Venice turpentine.

3rd. File the section down moderately thin, and then reduce further on the water of Ayr stone, examining from time to time with the microscope.

4th. Soak the section off with strong methylated spirit, wash thoroughly in clean spirit, and dry between tissue paper.

5th. Make a thin solution of white shellac in methylated spirit, filter and keep in a stoppered bottle.

The section is to be dipped in this solution, drained and laid down on a cold plate under a bell glass in about half an hour it will be dry.

6th. Mount in cold balsam and benzol in preference, in order to avoid heating the section, as that would give it a tendency to curl; but as the melting point of the shellac is higher than that of balsam, the latter *may* be used if thought desirable, as it may even be caused to boil without affecting the shellac.

After some remarks from Dr. Matthews, Mr. Hardy, and other members, the President closed the discussion by moving a vote of thanks to Mr. White and to Mr. Ady, which was carried unanimously.

The following objects were exhibited in the Library:—

Coralline, *Clava squamata*	Mr. F. W. Andrew.
Section of Ovary of Begonia	Mr. H. E. Freeman.
An Alga, mounted in 1864, in glycerine jelly...	Mr. H. G. Glasspoole.
Dendrosoma radians, &c.	Mr. J. D. Hardy.
Diatoms from Tarland, Aberdeenshire... ...	Mr. H. Morland.
Aquatic larva	Mr. F. A. Parsons.

Section of tooth of Hippopotamus	Mr. C. Le Pelley.
Sponge, *Mylinsia callocyathes*	Mr. B. W. Priest.
How & Co.'s pocket microscope lamp, with a light metal shade	Mr. G. Smith.
Section of Granite from Skiddaw	Mr. G. Smith.
Aulocodiscus angulatus, from the stomachs of Japanese tinned oysters	Mr. G. Sturt.

Attendance—Members, 74; Visitors, 6.

December 28th, 1883. Ordinary Meeting.

Dr. M. C. Cooke, M.A., A.L.S., President, in the Chair.

The minutes of the preceding meeting were read and confirmed.

The following gentlemen were balloted for, and duly elected members of the Club :—Mr. John Oliver, Mr. R. J. Spetch, and Rev. Geo. Bailey.

The following additions to the library were announced :—

"Journal of the Royal Microscopical Society"	From the Society.
"Proceedings of the Eastbourne Natural History Society"	" "
"Annual Report of the Brighton and Sussex Natural History Society"	" "
"Annual Report of the Croydon Natural History Society"	" "
"Proceedings of the Belgian Microscopical Society"	" "
"Science Gossip"	" Publisher.
"Science Monthly"	" "
"The Analyst" (weekly)	" Editor.
"The American Naturalist"	In Exchange.
"The American Monthly Microscopical Journal"	"
"Annals of Natural History"	Purchased.
Stein's "Infusoria"	"
Gosse's "Year at the Shore"	"
"Vestiges of the Natural History of Creation"	"
Pouchet's "Origine de la Vie"	"

The thanks of the Club were voted to the donors.

Mr. E. M. Nelson said that he had been asked by Mr. Curties to make a short communication on his behalf. Mr. Curties had lately received a packet of slides and a letter concerning them from Professor Smith, of Geneva, U.S.A. The slides were twelve in number, ten of them being mounted in one medium and two in another. What these media were the letter did not explain, but whatever they might be, the results were most beautiful. The ten seemed inclined to go bad, but the other two were mounted in something having a refractive index of 2·4, and the result was past all expectation, beating everything yet seen. The objects on these slides were *Amphipleura*

pellucida and *Navicula rhomboides*, and after having had the opportunity of examining them he was inclined to think that they marked a new era in diatom mounting: the results far surpassed all that had been done in phosphorus. If the new process proved to be a success as to its permanence, no doubt the details would be published in due course.

Mr. Ingpen said they could only look forward with some eagerness to the publication of a matter so likely to be advantageous to microscopists generally. He thought better of phosphorus, however, than Mr. Nelson did, and he had hoped to be able that evening to show some objects mounted in phosphorus of a higher refractive index than had hitherto been obtained. The fault with most of the slides yet exhibited was that the solution of phosphorus was not sufficiently saturated; but a friend of his had been turning his attention to the matter, and was trying some experiments with the idea of being able to mount some diatoms in absolutely solid phosphorus, from which very much better results were anticipated. Until his friend was able to come and state what he had done it would, perhaps, not be quite safe to say much about it, but he could not think that any substance could have much value for this purpose unless it had a refractive index as high as phosphorus. Some of the diatoms themselves possessed so high a refractive index that a very little difference, or only a slight lowering of the refractive index of the medium, would make an enormous difference in the visibility of the object. It was easy to see, by pressing the cover glass, that in most of these slides the centre was still fluid, and that therefore there was some of the bisulphide of carbon remaining.

Mr. Nelson said with regard to the relation of aperture to power, a question which seemed to be exciting some degree of interest just now, he had made an ideal table of what the various powers ought to be if they were to be perfect. 1in. being 30°, $\frac{1}{6}$in. should be 1·56, which had yet to be made.

Mr. A. D. Michael exhibited, and described, a specimen of the so-called "lungs" of a spider (*Tegenaria domestica*); and illustrated his description by means of black-board drawings. Mr. Michael said that this was possibly the most profound of the many modifications to which tracheæ were subject. The primitive tracheal system was, probably, that paired, lateral stigmata existed in the intersegmental membrane between each somite; and that, from each of such stigmata, a single unbranched trachea proceeded inward to supply the somite. Something like this existed in some *Myriapoda*, and was very instructive. In the *Acarina* the somatic arrangement was lost, not only in the tracheæ, but also in the whole structure; yet the simple, unbranched condition of the tracheæ was often preserved, as in the *Oribatidæ;* but the stigmata were few, and usually near together. In the *Insecta* the tracheæ anastomosed so freely that the simple type was quite lost. We got the intersomatic stigmata; but the tracheæ, after proceeding inwards for a short distance, usually united so as to form (as in the larvæ of *Lepidoptera*) a great lateral trunk along each side of the body, from which numerous, richly-branching tracheæ arose, distributed in profusion to the various organs. In spiders two classes were found, one with only tracheæ of the

ordinary kind, and the other provided with the organs termed "lungs." The present species was a good example of the latter class. The organ was formed thus: the tracheæ proceeded inward for a short distance, and then expanded into a wide sac, the inner walls of which were so plicated as to form a number of internal pockets, like the leaves of an uncut book, each pocket communicating with a central chamber, which was joined to the stigma by the short tracheal trunk before mentioned. Thus all the pockets were full of air, and usually lay horizontally above one another, as though the book were lying on its side. The blood entered the sac by special ostia, and circulated freely between the leaves or pockets, becoming aërated in the process. It was then carried forward by efferent pulmonary sinuses to the pericardial sinus. Expiration was supposed to be effected by muscles passing between the dorsal and ventral surfaces which compressed the leaves. The course of the blood in spiders had been carefully studied by Claparède, and was one of the numerous investigations which excited our wonder how that naturalist, who died so young, managed to do so much and such accurate work. He observed it in very young, living specimens, which were sufficiently transparent to enable him to see the actual circulation under his microscope. In insects the blood takes a backward course on the ventral surface, and the circulatory system is there greatly lacunar, but the blood is driven forward through the great dorsal, pulsating vessel. In spiders, however, Claparède found that the course was different—the blood entered the dorsal vessel by ostia near the centre, and was driven in both directions, some forward, some backward; so that there may be said to be two aortæ, one anterior and another posterior, the latter being the principal. It resulted from this divided course of the blood that it was not the whole of the circulating fluid that passed through the pulmonary sacs during each circulation, but only a portion. Scorpions usually had eight pulmonary sacs; spiders two or four placed in the fore part of the ventral surface of the abdomen. In some instances each sac might contain as many as 150 leaves.

Mr. G. C. Karop enquired if the sac-like leaves figured by Mr. Michael were open at both ends or whether at one end only, so that the blood circulated between?

Mr. Michael said the latter was the case.

Dr. Matthews asked if these lamellæ presented any analogy to the gills of fishes? Also how did naturalists suppose that the entrance and exit of the air was effected?

Mr. Michael said the lamellæ were to a certain extent analogous to the gills in structure, only they were not broken up into small leaves, and in gills the blood circulated in closed vessels in an aërated medium, while in tracheæ it was the air which circulated in closed vessels. The only explanation as to the inspirations and expirations was that the compression of the tracheæ by the muscles, and the telescopic retraction of the segments, would expel air; and when the pressure was relaxed, or the segments extended, it would be drawn in. Others, however, had thought that it was done by a double set of tracheæ.

Mr. Karop said the difficulty arising from this explanation was that if it only took place as a consequence of the muscular movements, then if the animal was held in one position there would be a suspension of muscular action, and its supply of air would be stopped.

Mr. Michael thought that when in a state of absolute quiescence there would be very little call for aëration of the blood, though he imagined that absolute quiet was scarcely possible. The involuntary movements of the abdomen and its parts would be sufficient for the purpose, whilst when more rapid movement took place the necessary supply would be increased in proportion. In the chrysalis stage very little would probably be required.

Dr. Matthews asked if there were any muscles demonstrable as being engaged in the processes of respiration ?

Mr. Michael did not think that any person had ever demonstrated the existence of a muscular coating, and as to other special muscles, the probability was that the tracheæ of two different specimens of the same insect would not lie in the same place. In reply to a question from Mr. Hardy, Mr. Michael said that the blood was not contained in capillaries, uniting an arterial and venous system.

The thanks of the meeting were unanimously voted to Mr. Michael for his communication.

The President intimated that the Secretary of the Lambeth Field Club had invited the assistance of the members of the Quekett Microscopical Club on the occasion of a Soirée arranged to be held on January 7th, at St. Phillip's Schools.

Announcements of meetings, &c., for the ensuing month were then made, and the proceedings terminated with the usual conversazione, and the following objects were exhibited :—

Section of Aloe	Mr. F. W. Andrews.
„ *Spirorbis nautiloides*	Mr. H. Epps.
Acarus, *Myobia* sp. from Mole	Mr. H. R. Gregory.
Raphides in *Lemna trisulca*	Mr. G. E. Mainland.
Lung of Spider, *Tegenaria domestica*	Mr. A. D. Michael.
Eggs of parasite of Toucan	Mr. C. Le Pelley.
Section of petiole of *Eucalyptus globulus* ...	Mr. J. W. Reed.
Gerris (Skater)	Mr. A. W. Stokes.

Attendance—Members 45 ; Visitors 2.

Notes on the Florideæ and on some Newly-Found Antheridia.

By T. H. Buffham.

Read February 22nd, 1884.

PLATES X., XI., XII.

It is well known that the dried forms of the Red Marine Algæ have long been regarded as beautiful and desirable possessions, but since the use of the microscope was found necessary to enable the botanist to properly classify these plants they have become legitimate and attractive objects for everyone who cares to become acquainted with the various classes constituting the lower Cryptogamia. It was, of course, soon found that the form and disposition of the fruit were of great variety, and must be taken into account by the systematist, and this gave an impulse to collectors who would assist in completing our knowledge of all the species composing the large sub-class called *Rhodospermeæ,* and now generally spoken of as *Florideæ.*

Although since the more general use of the microscope a great extension of our knowledge of the modes of growth, development, and reproduction of the smaller plants has resulted, it is only comparatively recently that the chain of evidence was so far completed that we may now confidently speak of some formerly doubtful points. It should be understood that this paper deals only with the sub-class just named.

When the late Prof. Harvey published his splendid "Phycologia Britannica" containing life-sized coloured figures of every plant, with numerous magnified representations of dissections and of the fruits then known, he made therein no attempt to clear up the functions of the various kinds of fruit found on many species. These were :

1. A compound fruit which, when mature, became detached from the parent plant, and then usually broke up into four portions, each of which was found capable of growing into a new plant. This is the *tetraspore.*

2. A still more compound fruit containing, or composed of, numerous bodies of similar size to, or smaller than, a tetraspore. To this kind of fruit were given various names according to the structure, form, and position, as *ceramidium* (urn-shaped), as in *Polysiphonia; coccidium* (globose body, frequently half-immersed), as in *Plocamium; favellidium* (globose mass immersed), as in *Naccaria; favella* (berry-like), as in *Ceramium* and *Callithamnion.* The contained bodies were called *spores,* and were also found able to originate new plants. These two kinds of fruit were found on most of the species, and if but one was then known it was generally believed that the other existed.

3. On a few plants were found a curious kind of fruit which Harvey called *antheridia* in those instances where their position, as in *Polysiphonia,* was distinct from either the tetraspores or ceramidia. But in the genus *Callithamnion* he found some bodies whose structure was similar to that of the antheridia of *Polysiphonia,* but their position on the ramuli was exactly similar to that of the tetraspores. About these he seemed doubtful, and sometimes suggested the provisional term "viviparous tetraspores."

In *Polysiphonia fibrata* the antheridium is a sausage-shaped body, consisting of numerous minute pale granules developed round a central axis borne on a thin pedicel near the apex of the ultimate ramuli. The appearance suggested a function analagous to that of the anther of a flower, but, as no proof could be given, opinions were divided as to whether the constituents of the antheridium fertilised the germ of a tetraspore or a ceramidium. I believe Harvey's own view was that the fruits containing numerous spores were the product of such a union.

These three kinds of fruits were always found on different individuals.

I may just mention here, with regard to this particular point, that I have found the following species containing two kinds of fruit on a plant :—

Polysiphonia fastigiata : antheridia and ceramidia growing intermixed over the whole plant.

Plocamium coccineum ; a fine plant, divided near the base, bearing tetraspores on one half and coccidia on the other.

Callithamnion tetragonum : a few favellæ on a plant bearing tetraspores.

C. tetricum : the same combination.

I have spoken more fully of the work of Harvey as there appears to have been little or nothing published in this country since then on the microscopic features of the fruits of British marine algæ, and any student desiring to add to our knowledge of this section of our native flora should make the "Phycologia Britannica" a starting point.*

In the meantime continental botanists have worked assiduously on the mode of reproduction of the Florideæ. The most important discovery was published by the French algologists Bornet et Thuret who found an organ on several species which enabled them to establish the true character of the three kinds of fruit named above, and their discovery has given a renewed interest to this beautiful group.

The tetraspores, then, are the asexual form of reproduction, and are of the nature of gemmæ or buds, and we thus clear the way for a statement of the true sexual process.

When a plant—say of *Callithamnion tetricum*—is destined to bear the true spores small rounded projections appear near the extremities of the ramuli, usually laterally, but in this species less so than in most, and very early in its development, while still a *procarp*, a minute process is put forth from near the apex of the bulging part. This is the important organ the discovery of which is above noted, and it is called the *trichogyne*. In Plate X., Fig. 1, I have drawn the mature unfertilised organ on a plant of *C. tetricum*, as seen with $\frac{1}{6}$ inch objective × 300. It consists of a hyaline cylinder or tube expanding slightly into a bulbous apex, with a slightly darker central axis which terminates at the base of the bulb. At this stage I have not been able to detect certainly any granulation. Measurements in these objects are of little value, for the variability is great, but its length is about ·002 inch, and its diameter ·0002. In Fig. 2 is a trichogyne of the same species × 500 (the procarp—not drawn—being in a similar stage of development to the other). Attached to the trichogyne are three of the minute ellipsoidal bodies from the antheridium called *antherozoids*. These are also colourless, and their granular contents are in process of transferring themselves through the hyaline exterior of the trichogyne into its darker centre which now shows an irregular granulation. Very shortly after this, in most species, the tricho-

* I cannot sufficiently acknowledge my indebtedness to this invaluable and unrivalled work.

gyne dwindles away, and the procarp proceeds onwards in its development, and becomes the *cystocarp*—the favella, ceramidium, or other sporiferous fruit of Harvey. I had previously examined many species of algæ without succeeding in getting a good view of the trichogynes and the fertilization, until I found, in Torbay last August, the instructive specimen here described.

There is no clear proof that the antherozoids are possessed of any power of transporting themselves. As in the flowering plants a large number of pollen-grains are provided,—although only a few are essential to the actual process of fertilization—so in the Florideæ it is the immense number of antherozoids which promises due contact with the trichogyne. Four is the largest number I have observed attached to a single trichogyne in *C. tetricum.* No doubt the action of the waves is chiefly effectual in securing contact, but Prof. Dodel-Port believes the currents made by Vorticellæ materially assist in the attainment of this result. If his suggestion is correct it would furnish another interesting example of the interdependence of animals and plants in the perpetuation of either.

While the cystocarps and tetraspores are fully described in the "Phycologia Britannica," and must be studied before a knowledge of the different species can be gained, it is the antheridia that best repay the microscopist for minute observation. I shall, however, confine my remarks on the present occasion to a description of those species only which are not figured by Harvey, and, as far as I know, have not been observed on British algæ before. Unless otherwise stated they were found in Torbay in Aug. 1883.

In Aug., 1881, my friend Mr. W. H. Gilburt, and I were collecting together near Teignmouth, S. Devon, when he found *Callithamnion tetricum* with antheridia. It has already been mentioned that these fruits occupy in this genus a similar position to that of the tetraspores. The latter fruit is on the inner sides of short lateral ramuli on the pinnæ. In the specimen taken, as above, the antheridia appeared to be almost terminal. I took this fruit in August last in Torbay, and, comparing them with the others, I am led to think the Teignmouth antheridia were older and had lost portions of the antherozoids. In the Torbay specimens (see Fig. 3, as shown with $\frac{1}{4}$ inch $\times$ 200) the principal portion is on the inner face of the ramulus, but it surrounds the ramulus so that a part is seen on the outer side. Note how by the growth of the antheridium the ramulus is bent down.

Call. byssoideum is a very interesting plant on account of the excessive tenuity of its ramuli, although the plant itself is from 2 to 4 inches in height. In Fig. 4 a minute portion of a branch is drawn as seen with a power of 40. The apical part of one of the filaments there shewn is drawn at Fig. 5 as seen with $\frac{1}{6}$ inch × 600. It bears three antheridia which are the most delicate objects of this kind I have ever seen. They are quite hyaline, with the exception of the cellules forming the axis. The antherozoids are very elongated, and their attachment can scarcely be made out in the only specimen I have yet seen, which was taken at Dartmouth last August.

Our next is a very different plant—*Call. Turneri.* The height of the specimen is scarcely $\frac{1}{4}$ inch, and of this fig. 6 shows only the upper portion as seen with $\frac{1}{4}$ inch × 200. Here the antheridia cluster thickly on the ramuli. Some are seen arising from ramuli behind the anterior ones. They are of various stages of development; of ellipsoidal form, not quite regular; colourless, and filled with antherozoids. I found this thickly investing a larger alga at Brighton in July, 1882.

In April of the same year I took at Folkestone *Call. roseum* with antheridia. These are globose when near maturity, but are so thickly placed on the ramuli in the position usually occupied by the tetraspores, that as they become older they almost coalesce, so as to form a continuous band. Their general appearance is very similar to that of *Call. polyspermum* figured in "Phycologia Britannica."

The last example of antheridia in this beautiful genus that I have to describe is one that Harvey truly designates "a charming plant," which we will continue for the present to call *Call. Plumula*, although it has been given various other generic names on the continent. In my specimen the ramuli are very close, and from these branch out numerous compound ramuli. In Pl. XI. Fig 1, one of the ramuli is shown having three antheridia on it × 80. In Fig. 2 the same three antheridia are drawn as seen with $\frac{1}{6}$ inch × 1,000, and in various stages of development, the largest being, of course, the most mature. The pedicel is prolonged into the antheridium, and is branched and sub-divided several times, the antheridium becoming, in fact, a lovely little shrub,—if such a term be allowable for an object measuring about ·001 inch in height. They are found on the compound ramuli as well. Although drawn as simply as possible to render their structure more comprehensible they

are to be found in pairs, triplets, and clusters, all rising from one cell of the ramulus. To make up by numbers for lack of size I may mention that in one field of a diameter of ·03 inch I have counted as many as 80 antheridia.

Near the same place I collected a very brightly coloured specimen of *Griffithsia corallina* which on examination was found to have antheridia clustering round the filament at the junction of two cells. With a power of 25 it appears as in Fig. 3. With $\frac{1}{4}$ inch $\times$ 200 each antheridium is seen to be a highly complex and beautifully symmetrical body, composed of a vast number of colourless antherozoids on semi-transparent branches. For clearness it is drawn as it would appear when separated from the filament. With $\frac{1}{6}$ inch $\times$ 800 the antherozoids are found to be pear-shaped and pointed, and show indications of some kind of granulation.

Most persons are more or less familiar with *Ptilota elegans* (*sericea* of Harvey) as a microscopic object. In its barren state, when luxuriantly grown, it is, under the microscope, perhaps the handsomest alga of our shores. I have, however, observed that it seldom has fruit when the plumules are recent and symmetrically grown. It seems to require age before it fruits. In a gathering of the plant with favellæ (cystocarps) I found a small tuft bearing few of this form of fruit, but several procarps with their trichogynes, and on the pinnules a large number of bodies that I cannot doubt are antheridia. They occupy the positions where the tetraspores are usually found, that is, terminal, or nearly so, on the ultimate ramuli, and are composed of a number of minute granules or cellules of pale colour. They are most likely immature, as the antherozoids can scarcely be well seen, although the exterior of some of the antheridia seems breaking up in the usual manner; $\frac{1}{4}$ inch $\times$ 200 shows them as in Pl. XII., Fig. 1.

Perhaps the most ubiquitous of the red algæ is *Ceramium rubrum*. The cystocarps are extremely common, yet antheridia have, I believe, never been found on our coasts. I have been fortunate in finding this fruit on two other species of this large genus, namely *diaphanum* and *strictum*.

In *Cer. diaphanum* the appearance with a power of 50 is both peculiar and attractive. Instead of the crisp borders and deeply coloured granules of the swollen joints as ordinarily seen the colour is softened down, and the fluffy borders suggest an interposed soft layer of semi-translucent substance only half concealing the

coloured granules of the filament: the appearance is velvety and beautiful. In Fig. 2 I have but feebly succeeded in indicating these different appearances. The antheridia, in fact, form a colourless layer round the coloured dissepiments on the upper branches to the apices, and on the short lateral dichotomous ramuli. With $\frac{1}{4}$ inch $\times$ 200, as in Fig. 3, the antherozoids are seen to be pretty closely set by a prolonged pedicel in the colourless investment of the dissepiments, radiating from the filament. A tendency to cluster round several centres can be perceived.

Cer. strictum is a slenderer and more delicate plant. Fig. 4 shows two dissepiments—with and without antheridia—$\times$ 50. As the colour is brighter the peculiar velvety look is even more striking than in *diaphanum.*

In fig. 5, as shewn with $\frac{1}{6}$ inch $\times$ 300 the antherozoids are minuter and more closely set than in the other species, but the general characters are alike in both.

At Teignmouth, in Aug., 1881, *Polysiphonia fibrillosa* was found bearing antheridia. They have the general characters of that fruit in this genus.

P. elongata has, however, large antheridia, which are very copious at the apices of the filaments, of conical form, with the axis much prolonged beyond the antherozoids. This I took at Folkestone in April, 1882.

There is yet ample work to be done before the fruits of all our native red algæ have been carefully observed with suitable powers, and their special features described and delineated. As already indicated, this refers more particularly to the antheridia than to the tetraspores and cystocarps.

But even as regards the latter I may give an instance. In the "Phy. Brit." Harvey figured *Helicothamnion scorpioides*, one of the most remarkable of the Florideæ, with its ramuli rolled inwards in spirals. But although he gave a number of localities he was unable to draw any fruit, as his herbarium only contained barren specimens. I believe, however, that tetraspores in stichidia have since been seen by several collectors. In a quantity sent me by Mr. E. M. Holmes, which he gathered near Portland Station in Aug., 1882, this fruit was not uncommon, as he had of course observed. On looking it over carefully I found one small fragment very rich in cystocarps, and although only enough for one slide, it is so characteristic, and unlike any other alga, that it will enable

that algologist to correctly describe this fruit at a suitable opportunity. I will only say here that it is terminal, although it was supposed to have been lateral. It is, however, very probable that this is the first cystocarpic fruit seen of this curious species, more correctly known now as *Bostrychia scorpioides*.

I saw the plant in great plenty at Stoke Gabriel on the River Dart last August, and although tetraspores were abundant the most careful search gave me no additional specimen of the cystocarps.

DESCRIPTION OF PLATES.

Plate X.

Fig. 1.—Procarp and trichogyne of *Callithamnion tetricum* × 300.
2.—Trichogyne of the same with three antherozoids attached × 500.
3.—Antheridium of the same × 200.
4.—Small portion of *Call. byssoideum* × 40.
5.—Three antheridia of the same × 600.
6.—Antheridia of *Call. Turneri* × 200.

Plate XI.

Fig. 1.—*Call. Plumula* with three antheridia × 80.
2.—The same, showing different stages of development × 1,000.
3.—Portion of a filament of *Griffithsia corallina* with three antheridia *in situ* × 25.
4.—An antheridium of the same removed × 200.
5.—Antherozoids of the same × 800.

Plate XII.

Fig. 1.—Two antheridia of *Ptilota elegans* × 200.
2.—Two dissepiments of *Ceramium diaphanum*, the upper one surrounded with antheridia, × 50.
3.—The latter × 200.
4.—Two dissepiments of *Cer. strictum*, the upper one invested with antheridia, × 50.
5.—The latter × 300.

On Parasitic Vegetable Organisms in Calcareous Particles of the Gabbard and Galloper Sands.

By J. G. Waller.

Read March 28th, 1884.

PLATES XIII., XIV., XV.

It is of frequent experience in the pursuit of a subject, which, at first sight, may seem to be bounded by narrow limits, that our views become the more and more extended the more we advance. This is at once the charm and the exciting incentive of science, and particularly that which belongs to natural history. When I began the subject of "Sand," I thought I should end with the determination, that the chalk flints, on our southern and eastern coasts, were very insignificantly represented, even in the midst of their *débris* of shingle; and that the great factor of our shore sands, as well as of that of ancient deposits, was quartz. I soon became convinced, however, that several questions, relating to the origin of this abundant material, were involved in the inquiry—difficult to account for, or to explain—but which might be solved by an extensive examination of deposits, ancient and modern. Thus it was, I interested my friend, Mr. John Inglis, Secretary of the Trinity House, to procure me specimens of sand from the shoals off the coast, which were under the jurisdiction of that corporation, at such times as convenience served. Amongst numerous specimens, thus obtained, were some from three sands lying off our eastern coasts, mainly between the estuary of the Stour and Orwell and that of the Thames. These are named in charts as the "Inner and Outer Gabbards" and the "Galloper." The nearest of these is the "Inner Gabbard," which is twenty-three miles eastwards from the estuary of the Stour and Orwell. It is about $2\frac{1}{4}$ miles long, and not quite half a mile wide, a measure taken from its upper surface, and, at low tide, has from two to three fathoms depth of water over it. About 5 miles distant from this, east by north, is the "Outer Gabbard," whose measure, taken in the same manner, is but $\frac{3}{4}$ of a mile full long, and of a somewhat less diameter than the last. About $9\frac{3}{4}$ miles S.W.

of this, and about 6½ miles S. of the "Inner Gabbard," is the "Galloper," about 3½ miles long, and generally similar to the two others in diameter and depth of water over them at low tide. All three have a certain parallelism to our coasts. The depth of soundings between them runs to 14 and 16 fathoms.

The character of all these sands is the same; so much so that, on microscopic examination, no one could distinguish between them. Large grains of quartz form the staple, intermingled with calcareous particles derived from shells of molluscs, particularly a small pecten, fragments of polypidoms, echini, &c., &c., all rounded and worn by attrition—a coarse-looking sand, whose calcareous particles rarely exceed ½ inch in diameter, and are generally very much less. Not a single fragment of any kind soever occurs of our chalk flint *débris*. It is quite obvious that none of our coasts, which here belong to the Tertiary system, have had anything to do in the making of these deposits. The specimens of sand obtained for me from the light-ships, were not taken from the shallow surface above indicated, but from a sounding perhaps of 6 fathoms around these shoals. I state systematically all the conditions before I proceed to give you an account of the remarkable parasitic flora found excavating in the calcareous particles.

It is no new discovery to find parasitic vegetable forms, either to be classed with Algæ or Fungi, in calcareous matter. Many observers, both English and foreign, have noted the fact. In the "Transactions of the Microscopic Society" in 1855, is a paper by Mr. Rose, with figures, of excavations in fish scales found in the chalk. Kützing, Kölliker, and Pringsheim have also assiduously worked in this direction.

Mr. H. N. Moseley, the naturalist of the "Challenger" Expedition, has the following note on the subject: "The Corallum of both *Millepora* and *Pocillopora* is permeated by fine ramified canals, formed by parasitic vegetable organisms of the same nature as those described by Dr. Carpenter and Professor Kölliker as occurring in the shells of mollusks, &c." He assumes them to belong to the Fungi ("Proceedings of Roy. Society," No. 164).

Professor P. M. Duncan has an interesting communication made in 1876 to the Geological Society, "On some unicellular Algæ, parasitic within Silurian and Tertiary Corals, &c.," which shows how remotely in the world's history this phenomenon occurred. It is now my part to state that, in our own seas, the same law pre-

vails as in those countless ages past, and I shall further show you that these organisms, living and fructifying many fathoms deep off our coast, may be illustrated by what are found in our woods, not much beyond the Metropolitan area, as well as in the Silurian corals.

The grains of calcareous sand in which they are found vary in size from the twentieth to half the inch, and there are proofs, that it is whilst in this comminuted state the plants grow and flourish, as some directly conform to the rounded shapes of the particles. They are in all conditions. Some beginning their development from mere granules; some fully developed; some exhibiting their reproductive powers; and of others we see but their excavations. Though it must be obvious, that there is much difficulty in following out the life-history of organisms growing under such special conditions, I have been careful to note every fact which examination by the microscope has given to me; and I have derived much aid from the admirable handbook of the "British Fungi" of our President (Dr. M. C. Cooke). I believe I shall be found to be correct, when I refer these plants to the Fungi, but it is well to state, that there have been conflicts of opinion respecting organisms closely allied, some placing them, or at least some species, amongst the Confervæ, or with the Algæ. But there seems now to be a pretty general consent that they belong to a group of the Fungi. Kölliker says—"It seems to me probable that the parasites dissolve the carbonate of lime of the hard structures, into which they penetrate by means of exudation of carbonic acid, which secretion would seem to take place only at the growing ends of the fungial tubes."*

Without attempting to class the organisms, which I shall now place before you, amongst forms developing under other conditions, I must, however, draw your attention to the analogies which they exhibit, although that may only be superficial. We must keep in mind that we are dealing with excavations, and that none of the forms develope externally. There are two groups of Fungi, viz., the Perisporacei and the Sphæriacei, to which I must refer. The first is defined as having minute globular perithecia, bursting at the summit, being filled with a gelatinous substance "Sporidia produced in asci, subsequently often effused, simple, free, and mixed with the gelatine." That of the Sphæriacei is stated to have "the

* "Proceedings of Royal Society," June 9, 1859, Vol. x.

essential distinctive character in the globular, ovate, or flask-shaped conceptacle, or perithecium containing asci, which ultimately opens by a pore at its summit to discharge the spores." To this the name of ostiolum is given.

Now, in the forms I am about to describe, the analogies with the two classes I have just defined will be easily observed, whether they are globular or flask-shaped, they have a mean diameter of the 1,000th of an inch. Pl. XIII., Fig. 1, gives the simple globose form and ostiolum ; Fig. 2 is one similar, but seated upon a sex-radiate mycelium. This feature, however, must not be looked upon as constant, as in the appendages of Phyllactinia (Handbook &c., p. 646), for, oftentimes, it is found to be more irregular and sometimes wanting. At the ostiolum is seen a very minute clavate object, also the same in Fig. 11, though much larger, and at Fig. 10, these are grouped around the opening of a conceptacle. In form these resemble some of the paraphyses (Handbook, &c., p. 716).

In maturity, or at least in some forms, the pore, or ostiolum, becomes obsolete, and the interior of the conceptacle is exposed to the full extent of its diameter, and thus we get acquainted with the reproductive system. At Fig. 3 are seen several globose objects, and outside the margin of the conceptacle minute spores are escaping. Fig. 4 shows the same globose forms, and at Fig. 5, besides the phenomena of escaping spores, another object is seen within athwart the diameter of the conceptacle. A very similar form is shown in Fig. 6, and here is a flow of a mucilaginous substance of a pale yellow colour, filled with spores. It is also certain, that the spores in Figs. 3 and 5 must be held together by gelatinous matter, or they would clearly have been washed away, for we must remember under what conditions these are found. Another similar object, though varied in shape, is seen at Fig. 8, associated with globose forms. Figs. 7 and 9 give other shapes of the same. What part these play, or what title must be given to them, belongs to those who have made the Fungi a special study. They must have an important office, but one cannot say whether they be constant or how far the different shapes may make a species. None of these excavated cavities appear to have anything more than a mucilaginous lining. The larger globose objects may be oospores, and it is natural to conclude, that the minuter forms escaping may be the zoospores, perhaps, in their living condition, ciliated.

I now come to a very remarkable development shown in Fig. 12.

It consists of a similar globose conceptacle with a prominent ostiolum, seen best in Fig. 13, and a radiation from its base of ten long, obtusely pointed sporangia with mycelious threads issuing from them, in five cases fork-like or duplicate. These appear to have about ten rows of sporidia, subglobose in form, two together; one has discharged these, another partially so. Fig. 15 shows a similar arrangement, but only nine sporangia are visible and there is a breaking up of the ostiolum. At Fig. 14 the condition is abnormal, three exhausted conceptacles are conjoined together, only five sporangia are visible, and there is gemmation. These objects are exceedingly rare.

The elongation of the ostiolum introduces us to another form which culminates in that of the Italian oil or wine flask; at Figs. 17 it appears in its most elegant shape, and was found, unmixed with any other, in a small particle of shell from the Galloper Sand. It is remarkable for its attenuated neck, coinciding in this particular with *Sphæria ampullasca,* as given in "Handbook of British Fungi," stated to have been found in rotten oak at Shere, Surrey, (p. 876). But as many of the Sphæria take the flask-form, I merely point out the analogy. This is by no means uncommon, and in one example from the outer Gabbard, Fig. 19, in a mature state it is seen to be filled with similar globose objects as have previously been described. At Fig. 17, minute spores are shown as discharged from the ostiolum. Another remarkable example from the same deposit is shown at Fig. 16, wherein the flask-form is associated with the same radiating sporangia as in Fig. 12, but only seven are visible, yet there is no reason why there may not be the same number of ten, and, it is to be noted, that four of the terminating mycelia are fork-like as before. It is the only instance discovered of the flask-form with the external sporangia.

Hitherto these globose forms or excavators have been separate and distinct from each other, and somewhat symmetrical. I must now call attention to another variation or species, which is far more destructive, if I may use such a term. Its excavations are deeper, irregular, and it riddles the surfaces all over. Minute as is the agent it looks a formidable parasite under the microscope. I have this, as it begins in a few granular bodies, until it developes and completes its work. It has no pore or ostiolum, and has a confluent tendency, although preserving much of the same general form as those just described, and seeming to lead up to another

group, which excavates chambers in common. Figs. 20, show examples illustrative of the above remarks, and, in one instance, some spores are seen within the conceptacle. At Figs. 21, 22, 23, we have the confluent development, the first showing the plant complete, the two others the cleared or exhausted excavations, the circles mark the openings of the burrows. The confluent character I shall again refer to, but at present must pass to the consideration of a very rare species from a particle in the Galloper Sand, having no connection whatever with any of those previously described, except its globose form, and a diameter of 1000th of an inch (Plate XV., Fig. 1). It shows its surface to be formed of a network of ovate spores. At Fig. 2, is a thallus upon which two younger forms are developing. I refrain from either classifying this example or pointing out analogies, that belongs to those more acquainted with this department of natural history. Not more than five figures have been found, and only one, that given at Fig. 1, is complete.

We now pass to a species altogether distinct in character, which is interesting because of its similarity, in many ways, to what Prof. Duncan found in Silurian Corals. It is always in flat, not rounded, surfaces, burrowing in tubes of a generally equal diameter, beginning at the edges of the particles and meandering through them with occasional apertures to the surface, probably for discharging its spores, not interfering or anastomosing with each other, and avoiding any other excavation in its progress. It is not so frequent to find this in a complete state, but more often its exhausted tubes, yet, when found, it is of the same cinnamon brown colour, which is most prevalent amongst these organisms.

Pl. XIV., Fig. 1, is an example of that described, not containing any of its plasmic matter, and showing the circular apertures on the surface. The mean diameter of the tubes is about the 777th of an inch. There are other forms possessing the same characteristics, though, perhaps, with more simplicity, whose diameter is about the 2000th of an inch, but it is impossible to say how far they are to be regarded as separate. But at Fig. 5 is a form so distinct as to require a special notice, and as this was found intermingled with the last, it must be separated as another species. It has the singular habit of tubes quadradiate from a square centre, which extend at considerable length, and which have an extremely regular diameter of the 2000th of an inch. When, however, we pursue these lengthened

arms, we find a swelling (*b*), bag like yet definite, a sporangium which at once allies it to the *Saprolegnia* or *Achlya*, amongst which Prof. Duncan placed the parasitic forms he found in fossils, and in which also the above described examples must be placed. There is yet another form of great simplicity, which evidently belongs to this class, Pl. XV., Fig. 9, wherein the tube is also regular, of equal diameter, and similar to the last in its measure. But it proceeds in a series of curves, occurring in rhythmical regularity, each having an aperture to the surface. Of all the forms it is the most simple, and it was in a fragment of oyster-shell from the Varne Sand, the others being from the Outer Gabbard.

Another variety, very similar to Fig. 1., Pl. XIV., but perhaps with more regular excavations, is seen in Fig. 2, but is distinguished by its villous character, the whole surface having short bristles (Fig. 3). The diameter of the tube is about the 666th of an inch. In this the warm brown plasmic matter is well seen, and some globular bodies are visible (Fig. 3), but not very easily made out, on account of the dense medium interposing. At Fig. 4, however, globose forms are well pronounced, but they belong to that shown in Fig. 1, and are similar to what some writers have called gonidia. Extremely minute granular objects are also occasionally seen, as in *Saprolegnia ferax*, *Achlya prolifera*, &c.,* showing very distinctly the alliance.

The above-named genera, so close to each other, have hitherto stood on debatable ground, whether to be placed amongst the Algæ or Fungi ; but which the general feeling amongst eminent naturalists would now assign to the latter. My own opinion in such a matter would be of no value ; all I can say is, that the arguments adduced by those workers who take this view, appear to me to be sound, if not conclusive. The next example is the most remarkable of the objects under consideration.

If one were to describe this according to its general appearance, it would be as a confused medley of root-like fibres, or filaments, unsymmetrical, contorted, and with every variety of form. This, though roughly giving an idea, would be useless for any scientific purpose ; for sometimes this becomes exceedingly intricate, and developed to such a degree, that the calcareous particle is completely occupied, and presents itself as a dark mass, scarcely distinguishing any organization. At all times a delicate mycelium is seen pervading

* See "Intellectual Observer," Vol. v., "On Egg Parasites," by the Rev. M. J. Berkeley, Figs. 2, 10.

throughout, and giving some colour by its prevalence. Pl. XIV., Fig. 6, shows a small particle, about the 25th of an inch in diameter, which gives a good idea of the general appearance of the organism not unduly developed. The large globular bodies I shall refer to presently. At Fig. 7, is another specimen, in which the delicate mycelium is more seen, as well as other characteristics not unfrequent, in which there is confluence of parts without determinate form. Selecting an individual plant will now instruct us in details (Fig. 8). At the aperture (*a*) we see where the first beginning took place, often shown by a small mass of granular matter, thence it descended into the shell, developing itself with conidia or buds from its sides, and proceeding in an irregular succession of bulbous expansions. A filamentous mycelium grows from one of the conidia, then a narrow neck ends in the perithecium, which, opening out on the surface of the shell, disperses its spores.

This example gives the plant in its simplest condition, and so far explains its character. But its growth is most irregular. Sometimes it proceeds by a straight filament of similar diameter throughout, at others it is always altering its shape, and no precise definition can be given to it. When decalcified it is extremely brittle, and in mounting a specimen it broke up on mere pressure of the glass cover. Thus, some matters of detail became more easy of investigation. A group of connected bulb-like forms are here figured (Fig. 11), and a perithecium is shown in a side-view (Fig. 10). In another example the latter is found in a perfect condition before the spores are dispersed, and exhibits a transparent hyaline operculum; but the conditions under which it was seen prevented the use of high powers.

One specimen still further illustrates the reproductive mode by conidia, and showing several conditions (Fig. 9), and this is so like that given in figures of *Saprolegnia ferax*, that it helps us in our argument, which would place the latter amongst the Fungi, where hitherto the ground has been debatable. For if we assume the rest of these organisms to be so classed, we can scarcely omit this, and if I am right in assigning the plant I am describing to the *Saprolegnia*, by the same reasoning the place of that genus would be defined accordingly.

But this important example must be examined in detail, as it exhibits many gemmæ or conidia, using these terms according to the views of Tulasne, in different conditions of development. Of

the four larger figures, one seems to be nearly matured, and is of a globular form, and its tubular stem is free from all granular matter. One is on a membranous expansion, and some germination is apparent; another shows two mycelious threads issuing from it. In the upper portion of the canal, where the granular matter is partially obsolete from exposure to the surface, there are globose objects, perhaps oospores, and still farther are minute granules which appear to be escaping. Near to this is a depending sporangium, in which are seen four sporidia. This was from a particle found in the Outer Gabbard, but in another specimen from the Galloper the same form of sporangium is repeated twice or thrice. The relation this bears to the rest in its fructification is not a matter on which I can pretend to give any information or opinion.

There is another character often visible which has not yet been described. It may be called a glomerus, for it has a globose form very much larger in proportion than any other part, well shown in Pl. XIV., Figs. 6, 7, and Pl. XV., Figs. 3, 4. If its relative size can be an indication of its importance, that must be great, and it may be that its place is amongst resting spores. Occasionally a confluent and amorphous mass is seen, always at the edge of the particle, partaking of the same character.

It appeared to me to be necessary to examine, where possible, other of the sand deposits in the vicinity of the group wherein these organisms were found, as also of others off the coast, to ascertain whether they were peculiar to them alone or might be found dispersed about them. There is a long sand lying off the Suffolk coast called the "Shipwash," eight miles distant from the shore, and about eleven from the Inner Gabbard, between which and it there is an average of 14 to 24 fathoms. Some traces exist in this of them, but not in quantity. So, also, from a sounding taken at the Kentish Knock, about 11 miles more southerly, in 16 fathoms, also in the Long Sand, which stretches to the Thames entrance, they are to be found, and possibly in many other of the deposits, where calcareous particles are present. Pursuing the subject, I now examined a specimen of the Varne Sand, lying off Dover and Folkestone, but the nearest point of which is seven miles distant. The general appearance of this deposit is similar to those of the Gabbard and Galloper, but not so coarse. It contains the same calcareous particles, and these present us with similar forms, such

as have been described, though not in similar quantity. But it serves to show us how interesting the question becomes, thus pursued, when I tell you that this deposit has furnished two new forms of singular interest.

The first, I shall call your attention to, I must consider only as a variety of the last described. Yet this does not diminish its value. I pointed out that, that was remarkable mostly for its irregularity, its contorted, ever varying Protean character, often an entangled mass of filaments. Now, in the example under consideration, we get something more definite ; the filaments are disposed in branchlets, and we find a close analogy thus with many of the Algæ. These branchlets are more superficial, and do not penetrate deeply into the calcareous substance. Fig. 3, Pl. XV., is taken from one side of the particle, and shows the branch-like fronds distinctly. Fig. 4 is on the other side, and although the filaments look detached, it is not so, the stalk, as it were, being invisible from the density of the medium and its descending deeper into the substance. If we seek analogy to account for the larger globose object I have spoken of, perhaps it may be seen in many of the Fungi. In *Mucor Mucedo*, the branched mycelium, sending up a filament terminating in a conidio-spore, appears to have something of the character, although the form is different. All the other subordinate parts are so completely like the last described, and the constant delicate mycelium pervading the whole particle is so characteristic, that I cannot but speak of this as a variation, though probably to be considered as approaching a higher type of organization.

Last, not least in interest, is a form peculiar, not hitherto found at all. Viewing it alone, without any information as to its size, &c., we might easily assume it to be a sponge. It is in a minute particle of oyster shell, not exceeding the 20th of an inch, and the longest diameter of the object is 100th of an inch. Were this a sponge, we might rejoice in having the smallest in the world discovered off our coasts. Everything at first sight favours the idea of its being a minute *Cliona*. But we have to remember that, hitherto, all these parasitic organisms have been referred to the vegetable kingdom. Naturally, we should then look there for its place, unless it was otherwise strongly marked. As we see it, it is an excavating organism, which begins at one edge of the particle, and sends out branches in different directions. This is not to be accounted a peculiarity, but rather an accident, as other smaller

specimens do not so begin, but by a circular excavation. It is covered with stiff, villous appendages, which, in parts, group round globose elevations, possibly sporangia. Smaller specimens, in which the yellow organic matter is absent from decay, show us distinctly that here are similar circular cavities as in Fig. 14, but it is more confluent. These, and the fact that one example shows us globose fruit, seem distinctly to place this amongst the general class of vegetable organisms parasitical in the calcareous particles of these sands.

I have previously noticed the villous character in the object given in Pl. XIV., Figs. 2, 3, and that this is common amongst the Fungi is shown by those ranged under "Sphæria villosa," the "Venturia, Pyrenophora" in the same general family. There is also the genus Vermicularia, in another class, as well as Volutella. In the Perisporacei "Chætonium" is remarkable for the long hairs radiating around the perithecium, which is very illustrative of this species. (See "Hand-book of British Fungi," pp. 438, 556, 652, 856, 925.) In Pl. XV., Fig. 6, is another example, but here all the endochrome has disappeared, so also in Figs. 7 and 8. The latter seem to be early conditions or forms of the same plant, and Fig. 7 shows some analogy with that of Pl. XIII., Fig. 23, in its confluent character. All the forms appear on the same minute fragment of shell, and have not, as yet, been elsewhere found. Pl. XV., Fig. 5, shows an excavation of minute kind very similar to what are figured by Mr. Rose as found in fish scales of the chalk.

In Prof. Kölliker's paper in the "Quarterly Journal of Microscopic Science," July, 1860, which is similar in its facts to what appeared in that already referred to amongst the Proceedings of the Royal Society, gives several figures in illustration. They have an affinity in character with one or two here described, but are not identical ; in the author's general views I coincide.

In reviewing the subject, I must apologise for many imperfections which necessarily beset one who is here but a novice. But, I have of late had but too many reminders that *vita brevis est*, and if one waits until we think our knowledge may be more matured, it would give a ready excuse for doing nothing. What I have here presented before you I am assured has much that is new ; it was, therefore, a duty to make it known to you. By this, there is at least some chance of gaining a new light on a subject admittedly obscure. A very able paper by Prof. P. M. Duncan, communicated to the Royal

Society in 1876, and published in their Proceedings, discusses very fully the questions of parasitic thallophytes in living corals. Some of the forms, engraved in illustration, have an unquestionable affinity to that which I have described in Pl. XIV., Figs. 5, 6, 8, 9; and he comes to the following conclusion:—That these parasites "belong to a group whose life-cycle is complicated by marine and sub-ærial conditions, and infers that *Achlya*, *Saprolegnia*, *Botrytis*, *Perenospora*, *Empusina*, and possibly *Bryopsis*, are so many names of the same organisms under different conditions." As far as I have been able to study the class, from general appearances and details, there seems to me good ground for this surmise. Certainly many of the forms in the fructification of *Perenospora infestans*, which affects the potato, are in striking analogy.* But, indeed, in the development of some of the Agarics, as far as outward form is concerned, you may get some illustration. Passing away from what are recognised as Fungi to the Algæ, and we can also find analogies. Vaucheria has been alluded to by some in illustration, and not without reason. Odonthalia shows in its fructification forms remarkably similar to those in Pl. XIII., Figs. 12, 13, and globular receptacles are common enough. Yet I think, when all things are taken into account, the weight of evidence arising from general character, will surely place these remarkable plants amongst the Fungi. I must conclude by stating that the subject is by no means exhausted, and this may prove, perhaps, only a beginning towards a better understanding of the life history.

Since writing the above, my attention has been drawn by our President to the Fungus foot of India, of which an account is given in the "Transactions of the Linnæan Society," with illustrations. The subject is also taken up by the Rev. M. J. Berkeley, in Vol. II. of the "Intellectual Observer," wherein the plates are copied, the drawings having originally been made by H. J. Carter, F.R.S. The character of the Fungus, as given in one illustration copied at p. 256 of the latter work, has several analogies with what I have given at Pl. XV., Figs. 3, 4, and which I place with the Saprolegnieæ. There are also at p. 253 in same work some figures which illustrate the object Pl. XV., Fig. 5.

* See Art. on Potato Fungus by Worthington G. Smith, "Monthly Microscopical Journal," Sept. 1, 1876.

As I have refrained from classifying many of the objects amongst known species of the Fungi, it may be useful at least to make some provisional arrangement, which future investigators may use or improve upon with better or more extended knowledge. I have therefore consulted Mr. H. J. Carter, and have adopted his suggestions and improvements. Leaving the question then whether the objects are to be finally arranged with Fungi or Algæ, it is proposed to include them under a general term, expressive of the conditions in which they are found, viz., as parasitic organisms excavating in calcareous matter, organic, or inorganic.

Entolitheæ.

Lacuneæ. Pl. XIII.

Organisms excavating globular, or subglobular, or flask-shape conceptacles, having a pore or ostiolum, which often becomes obsolete in maturity. Some without an ostiolum, some bearing external sporangia. Some confluent, all composed of a granular or mucilaginous substance, generally of a deep yellow. Spores globular, of a pale brown or yellow colour. Sometimes with a theca (?) athwart the conceptacle, which has a mean diameter of 1000th of an inch, and is sometimes seated on mycelia radiating from it.

(Lacuneæ. *L. globosa*, mihi.) Pl. XIII., Figs. 1, 2, 3, 4, 5, 6, 7, 8, 9.
(The same. *L. sporangifera*, mihi.) Do., Figs. 12, 13, 14, 15, 16.
(The same. *L. ampullæformis*, mihi.) Do., Figs. 17, 18, 19.
(The same. *L. confluens*, mihi.) Do., Figs. 20, 21, 22, 23.

Retesporeæ. Pl. XV., Figs. 1, 2.

Globular surface, making a network of spores in maturity, sometimes seated on a thallus : a warm yellow colour. It has a diameter of 1000th of an inch. Only one species discovered, and in the Galloper Sand.

(Retesporeæ. *R. Galloperi*, mihi.) Pl. XV., Figs. 1, 2.

In referring the next examples to the Saprolegnieæ and Achlyeæ, I have been guided by the general descriptions given and well known. As some obscurity of their true plan and even separation from each other is felt, I submit the classification with reserve.

(? Achlyeæ. *A. perforans*. mihi.) Pl. XIV., Fig. 1, 4.
(? The same. *A. villosa*, mihi.) Do., Figs. 2, 3.
(? The same. *A. quadradiata*, mihi.) Do., Fig. 5.
(? The same. *A. simplex*, mihi.) Pl. XV., Fig. 9.

(? Saprolegnicæ. *S. Gabbardensis*, mihi.) Pl. XIV., Figs. 8, 9, 10, 11.
(? The same. *S. Varniensis*, mihi.) Pl. XV., Figs. 3, 4.

Varnieæ.

This proposed genus is at present represented by one species, as yet only found in the Varne sand, hence the name. It makes confluent excavations which anastomose freely, simulating the thallus of some lichens. Spreading out in various directions with lobular terminal projections, possibly sporangia, marked throughout by stiff villous appendages, which group around the latter. It sometimes excavates from the sides, sometimes in the middle of the calcareous particles. Its fruit is globular.
(Varnieæ. *V. villosa*, mihi.) Pl. XV., Figs. 5, 6, 7, 8.

DESCRIPTION OF PLATES.

Plate XIII.

Fig. 1. Excavated conceptacle of *Lacuna globosa*, diam. 1000th of in.
Fig. 2. The same with radiating mycelia, diam. as above.
Fig. 3. Ditto with oospores (?) Zoospores (?) escaping, diam. as above.
Fig. 4. The same. Fig. 5, zoospores (?) escaping and a theca (?) athwart the conceptacle, diam. as above.
Fig. 6. Ditto. Spores issuing in a mucous, theca (?) as before, diam. as above.
Fig. 7, 8, 9. The same with different forms of thecæ (?) diam. as above.
Fig. 10. Conceptacle with forms similar to paraphyses, and at Fig. 11, diam. as above.
Fig. 12. *Lacuna sporangifera*, diam. of conceptacle 1000th of in., also Figs. 13, 14, 15.
Fig. 16. The same with flask-like conceptacle; an intermediate form.
Fig. 17. *Lacuna ampullæformis*. Various examples; one more amplified, ostiolum with spores escaped; diam. 1000th of in.
Fig. 18. An intermediate form between the last and that of *L. globosa*.
Fig. 19. *L. ampullæformis* with fruit; Oospores (?)
Fig. 20. *Lacuna confluens* together with Figs. 21, 22, 23, &c., exhibiting different stages or variations. The granular objects show the manner of commencing excavation. Same mean diameter as above to all the circular orifices.

Plate XIV.

Fig. 1. *Achlya perforans*, the tubes void of protoplasm; mean diam. of tubes, 777th of in.
Fig. 2. *Achlya villosa*, tubes filled with plasmic matter. At fig. 3 portion of tube more highly magnified to show villi. Mean diam. of tube 666th of in.

Fig. 4. Fructification of *Achlya pertorans.*

Fig. 5. *Achlya quadradiata*, diam. of tubes 2000th of inch. *b.* sporangium at the end of one of the branches.

Fig. 6. Particle of calcareous sand, showing organism within it (*Saprolegnia Gabbardensis*), longest diam. 25th of in. At Fig. 7 portion of another.

Fig. 8. *S. Gabbardensis.* A single specimen complete; *a* the aperture where the excavation began; length 65th of in.

Fig. 9. Ditto exhibiting the different modes of fructification. 250 diameters.

Fig. 10. Perithecium of same, long diam. about 3-1000ths of in.; Fig. 11 resting spores (?) removed by decalcification.

PLATE XV.

Fig. 1. *Retespora Galloperi*, diam. 1000th of in. Fig. 2, same developing on a thallus.

Fig. 3. *Saprolegnia Varniensis.* Fig. 4, same on reverse side.

Fig. 5. *Varneia*, containing its protoplasm; long diam. 100th of in. Figs. 7, 8, cavities empty.

Fig. 9. *Achlya simplex.* Tube, diam. 2000th of in.

Fig. 10. Excavation, similar to some figures given by Mr. Rose. " See Trans. Microscopical Society. 1855, p. 7.

PROCEEDINGS.

January 11th, 1884.—Conversational Meeting.

The second of the second series of demonstrations was given by Mr. J. D. Hardy, F.R.M.S., on the subject of microscopical drawing.

Reminding his audience that these demonstrations were intended to be entirely elementary, Mr. Hardy remarked on the utility of drawing *all* objects, and thus becoming acquainted more thoroughly with their details. To effect this there were two methods, viz., the mechanical and the artistic. By mechanical was meant drawing by the aid of some apparatus designed for the purpose; by artistic, drawing as an artist, by thoroughly appreciating the object to be drawn, and reproducing the mental image endowed with the artist's individuality. For drawing by the former method he described the old camera obscura, reflecting the image on to the glass or paper on which the object was to be drawn: the objections to this method being a great loss of light, and also a duplication of the image. As an improvement he exhibited a camera of his own construction, acting by direct lighting on to a flat field. This "direct camera" was an oblong box, about 20in. in length by 10in., having a hole at one end to admit the tube of the microscope. This box was provided with a sliding shutter for the purpose of stopping all extraneous light, and also to accommodate the height of the camera to that of the tube of the instrument. At the other end was a sheet of plate-glass, sliding in grooves, upon which was attached a sheet of paper to receive the image. The paper used was either plain tissue paper, or paper rendered semi-transparent with oil or paraffin. In using the microscope with this apparatus the long tube of the microscope was discarded for a short one about 2in. long, merely for the purpose of holding the object-glass. The ordinary lamp and condenser were used, and the image was thrown on the paper perfectly clear and distinct to its finest details. Various objects were shown under different powers of the object-glass, and outlines of such objects were exhibited. Referring to lantern drawings and transparencies, which could easily be made by this method, the speaker argued in favour of showing such objects as transparent against a black ground in place of the ordinarily black outlined objects, which appeared to him as misleading to an uninitiated audience. Passing on to the next grade in independent micro-drawing, he described the various forms of camera lucida, which, starting with the Amici, had been improved by various inventors—as Nachet, Zeiss, Wollaston, and others—and lastly by Shröeder, whose instrument (which was exhibited) was explained at a recent meeting of the Royal Microscopical Society. This camera was a great improvement on the others, giving a very clear image, and being more convenient to use. Mr. Hardy then described means for obtain-

ing an enlarged image by these cameras without altering the object-glass, so that large diagrams could be drawn direct from the object. He next described the various kinds of reflectors attached to the eye-piece, showing the objection to the use of them as reversing the image, and the means to be employed to obviate this defect. The next step towards the artistic method was the use of a cover-glass, ruled in squares and placed on the diaphragm in the eye-piece, the drawing being made through the medium of the eye on sectional paper. Different sized rulings on this paper were exhibited, with drawings, which showed that exactly proportionate drawings could thus be made from the same object and object-glass. The methods of transferring drawings into a note-book, or for other purposes, were shown and explained. The last method described was by viewing the object direct, and drawing on paper placed close to, and coincident with the stage of the microscope. The necessity of a knowledge of the form of the object, if solid, and of making such drawing according to the rules of perspective, were commented upon, and explained by diagrams on the black board. Mr. Hardy also spoke in favour of making drawings on black paper in Chinese white with a fine sable brush, and showed some drawings effected in this manner, enlarging upon the expression of character in a drawing done in this way in contra-distinction to a mere copy or outline.

After the demonstration some highly-finished coloured specimen drawings, kindly lent for the purpose, were exhibited, and various explanations were given.

The following objects were exhibited in the Library:—

Eggs of Prawn	Mr. F. W. Andrew.
Section of Serpentine from the Lizard, Cornwall	Mr. A. L. Corbett.
Section, Ovary of *Saxsifraga crassifolia* ...	Mr. H. E. Freeman.
Protococcus, Amœboid form	Mr. W. Goodwin.
Casts of Foraminifera, &c., from Calcareous Sandstone from Bombay	Mr. H. F. Hailes.
Diatoms, *Triceratium parallelum*, &c.	Mr. H. Morland.
Spider, *Clubiona*, polarized	Mr. T. S. Morten.
Bacillum of Tuberculosis, with half-inch object-glass	Mr. E. M. Nelson.
Sponge, *Farrea Ocea*, with the Tube of an Annelid composed of Spicules from *Corticum abyssi* and *Clione abyssorum* ...	Mr. B: W. Priest.
Cystolith in Cortex of *Ruellia portallæ* ...	Mr. J. W. Reed.
Oil Glands in Leaf of *Eucalyptus globulus* ...	" "
Star-fish, *Ophiocoma neglecta*, showing regeneration of limbs	Mr. A. W. Stokes.
Actinogonium septenarium, *Astrolampra decora*, &c., mounted in gum styrax ...	Mr. G. Sturt.
Fragillaria capucina	Mr. A. Wildy.

Attendance—Members, 108; Visitors, 9.

January 25th, 1884.—Ordinary Meeting.

Dr. M. C. Cooke, M.A., A.L.S., President, in the Chair.

The minutes of the preceding meeting were read and confirmed.

The following gentlemen were balloted for and duly elected members of the Club:—Mr. T. B. Rosseter and Dr. Alexander C. Macrae.

The following additions to the Library were announced:—

"Proceedings of the Royal Society"	From the Society.
"Proceedings of the Geologists' Association"	" "
"Proceedings of the Postal Microscopical Society"	" "
"Science Gossip"	Publisher.
"Science Monthly"	In Exchange.
"The American Naturalist"	" "
"The American Monthly Microscopical Journal"	" "
"Vignettes from Invisible Life"	From the Author.
"Lindberg's Moss Flora"	" "
"Annals of Natural History"	Purchased

The thanks of the Club were voted to the donors.

Mr J. A. Ollard exhibited a camera obscura for drawing microscopical objects, which was constructed by Ross for Dr. Millar about 25 years ago, and which he thought was better than the one shown by Mr. Hardy at his recent demonstration, inasmuch as it was fitted with two legs, which enabled it to be used at a convenient angle. It could be used either with light reflected from a mirror or with a lamp direct.

Mr. Hardy did not see that the fact of the box of the camera being inclined was any advantage, because it was likely to be much less rigid than when placed horizontally upon the table, in which position it could be got at very well by sitting upon a low stool.

The thanks of the meeting were voted to Mr. Ollard for his communication.

The President said that about 24 hours ago he had received an intimation from the Secretary to the effect that a paper was wanted for that evening, and as no one in the meantime had come forward with one, he would spend a few minutes in describing an organism which he thought might be of some interest. Most persons had probably noticed at some time after rainy weather, on the roadside and other places, what appeared at first sight to be a little lump of jelly. On examining it they would probably soon decide that it was of vegetable origin. Some would be disposed to regard it as a fungus, others would call it an alga; but it was in reality a Nostoc. Of this genus there were about 14 British species, but perhaps the only one of these which most persons were likely to meet with was the common species, the largest of them all; most of the others being found upon mountains on the dripping face of rocks. One of the rarer kinds he

had found on the walls of a greenhouse at Kew. In size the species varied from that of a pin's head to a diameter of two or three inches; but all of them had a similar structure, all consisting of a mass resembling isinglass jelly, enclosing a number of wavy threads, composed of small globose cells, attached end to end like a chain. The normal form of these cells was globose; if they were at any time found to be square or cubical, the variation was the result of some sort of compression to which they had been subjected. No other organs had been observed, so that the nostoc might be said to consist of a mass of jelly enclosing a number of moniliform threads. If these chains were examined by the microscope, it would be found that at variable distances larger cells were interjected, and these were supposed at one time to be spermatia. When seen under favourable circumstances it was possible to trace motionless cilia extending from these larger cells—now known as heterocysts; but notwithstanding the attention which had been given to them, their function was still as great a mystery as ever. They were in most cases easily recognised by their size, but they could also be distinguished by their colour, having a yellow endochrome instead of a green one like the other cells. When mounted, however, all colour disappeared, so that if the cells and the heterocysts happened to be of the same size it was then difficult to distinguish them; but supposing that there was no visible sheath enclosing the thread, a solution of iodine would be of use, as it would react more on one than on the other. Though their purpose was so little known, they were of considerable service in determining species. During the growth of the nostoc some remarkable changes took place in these cells, two or three or more of them in a thread would sometimes be seen to enlarge themselves, and having done this they would divide and break off, and at last be converted into spores. Why they should thus differentiate themselves was at present a puzzle, but it was clear that they did so, and that they became filled with granular matter, and finally germinated. Another mode of reproduction had been observed—portions of the threads between two heterocysts would break away, constituting what is termed a hormogone, and leaving the heterocysts in the jelly, would emerge and become living and moving, and might be seen to wriggle about; then they became broader and broader until they constituted a double thread of cells through their entire length, and then separated down the middle, becoming two threads; they then gathered a jelly about themselves, and this was the initial stage of a new nostoc. It would be seen, therefore, that they had a more peculiar mode of reproduction, exhibited by this genus, than was found amongst others of the algæ.

Mr. Michael said there was one little point which he did not thoroughly catch, as to the lateral widening in one direction giving rise to a new set of cells. Was this a widening of the original cell or a dividing of a cell?

Dr. Cooke said the process differed entirely from the ordinary method, which would be by the dividing of a cell; but in this case they had the cell itself gradually widening, instead of constricting, and this went on until it had become as large as two cells before any constriction took place. No nuclei had as yet been found.

Dr. Matthews inquired if the species described was an ally of that nostoc which grew in a night during damp weather, forming blood-red patches on a stone.

Dr. Cooke said that the organism referred to by Dr. Matthews was not a nostoc but another alga, and the nostocs were as wide apart from these algae as butterflies and beetles. The red patches were caused by an agglomeration of cells; it was always found to consist of simple free cells dividing in two directions, and they had never at any time been reckoned to have any affinity whatever. Nostocs also belonged to the green, and not the red group of algæ.

Dr. G. D. Brown asked for information as to an alga found in a pond having the appearance of pale sea green spores. On examining a drop of the water he found almost exactly what had been described.

Dr. Cooke said the form to which Dr. Brown had referred was not a true nostoc, but a member of the same family, some of them being found floating. This one had the structure of a nostoc except the jelly, but was free swimming; it belonged to the following genus, and came next in order to the one which had been described. It was one of those peculiar kinds which made their appearance in waters at certain times, and diffused themselves through the whole water, giving the appearance sometimes called "breaking of the waters." Attention had been given to it for some years.

Mr. E. T. Newton said it was not unusual to find in these things an alternation of generation. Did heat, or dampness, or dryness cause these changes?

Dr. Cooke said that the changes which he had described formed the ordinary mode of reproduction in the genus; all went through the same stages, the gelatine was always there and the threads were always there. Whilst observers confined themselves to $\frac{1}{4}$in. objectives it was supposed that all the cells were alike, but by using higher powers it was found that they became granular, then enlarged, then split away, and then began to germinate and form new threads inside the old gelatine, and the formation of a hormogone was found to be a usual process under favourable—that was under damp conditions. Many of the nostocs lived either in water or close to it, so that they would frequently get wetted. Of course if it got dried up it would shrivel up to a mere spot, and would be unable to carry on its existence.

Mr. Buffham asked what Dr. Cooke thought the heterocysts really were?

Dr. Cooke said he never allowed himself to *think* on these questions.

Mr. Buffham thought that the extension of knowledge had led to the increase of the number of species, showing sexual generation, and he could hardly help thinking that these might have some such function.

Dr. Cooke said there was at present no evidence as to what they were, and under those circumstances it would, he thought, be unsafe to make any suggestion. The heterocysts were left behind in the jelly, and apparently decayed away.

A vote of thanks to Dr. Cooke for his communication was unanimously passed.

Announcements of meetings, &c., for the ensuing month were then made, the President remarking that it seemed to be again necessary to urge upon members the duty of producing papers for their meetings, for he feared that the greater number of them thought that morally and religiously they had no other duty than that of showing their happy faces in the room. It was not necessary that something new should have been discovered in order to furnish a subject; not everything new was always true or had the most interest; indeed he did not know but that in the whole round of scientific enquiry they were not travelling too fast. There were many members whom they would be very happy to see stand up and re-classify known facts, so as to give an opportunity of judging whether their own method of viewing a subject was a correct one.

The proceedings terminated with the usual conversazione, and the following objects were exhibited:—

Prawn, *Hipolyte* from Jersey	Mr. F. W. Andrew.
Empis pennipes	Mr. H. E. Freeman.
Female inflorescence of *Corylus avellana* (Hazel)	Mr. G. E. Mainland.
Damæus nitens	Mr. A. D. Michael.
Parasite of Codfish	Mr. T. S. Morten.
Diatom n.s.	Mr. E. M. Nelson.
Tingis crassicornis	Mr. F. A. Parsons.
Ophrydium sessile	Mr. C. Le Pelley.
Minette from Jersey	Mr. G. Smith.
Syenite, with micro-pegmatite from Charnwood Forest	" "
Volcanic dust Java eruption	" "
Florets of Edelweiss	Mr. A. W. Stokes.
Sponge section, *Grantia ciliata*	Mr. J. Woollett.

Attendance—Members, 62; Visitors, 3.

Friday, February 8th, 1884.—Conversational Meeting.

Mr. J. G. Waller gave a demonstration—the third of the second series—the subject being "The sponge skeleton as a means of identifying genera and species." After giving a general view of the sponge and its natural division into three classes; Keratosa, or horny sponges, Silicea, or sponges making spicules of silex, Calcarea, or those making spicules of carbonate of lime; he proceeded to give an account of the genera of British sponges according to Dr. Bowerbank's classification, saying, that as a sponge begins its life by forming a membrane, so the lowest type would seem to be that which exhibits little development beyond it. This is shown in the true *Halisarca* (sea flesh), which is chiefly made up of sarcode and a small amount of keratose matter; a gelatinous substance scarcely having a skeleton properly so called. The advance upon this is what Dr. Bowerbank erroneously thought was the *true* Halisarca of Dr. Johnston, and which, on

finding minute spicules in its substance, he placed in his genus *Hymeniacidon*, under the name of *H. Dujardinii.* This genus is of simple character, consisting of membranes with spicules thrown upon them without any kind of defined arrangement. But, here, it is necessary to observe, that in all cases the external membrane, which encloses the sponge, must be well examined. This often differs very materially from the general skeleton, as shown by a section taken at right angles to the surface, which should always be done. For the membrane may have a defined reticulation and other characteristics diverse from the skeleton, and by this you distinguish species, as well as proclaim the alliance between genera. Spicules also may be found of a different form and character in membranes and sarcode, which do not belong to the skeleton. The acerate spicule, sharp at both ends, and the acuate spicule, as a needle sharp only at one end, form the great staple of the spicules of the skeleton, mostly found in their various modifications of spinous, fusiform, pin-like, clavate, &c., whereas the flesh spicule, or that of membranes, takes the anchorate, in its various forms, the stellate, tricurvate, bihamate and forcipiform, &c.

Although *Hymeniacidon* may be represented in a very simple condition, yet in a complex multiplication of membranes and spicules it may become a compact mass, as firm as a piece of cork when dry, and thus it is, one of its species is called " *Suberea*," and foreign observers have even constituted a special genus under the title of " Suberites."

In the group now selected, the next allied in organization, but separated from *Hymeniacidon* under the name of *Raphiodesma* (from the Greek, needle and bond) differs from the former, mainly, that it has fasciculi of spicules, not combined together in a network, but lying indiscriminately and without much order. It seems, nevertheless, to be a definite advance. The genus is exceedingly interesting and worthy of study, and most of its species develope on its membranes beautifully-formed rosettes of anchorate spicules. It also appears to lead up to another genus, where the fasciculi have become a close and compact network, well bound in keratose membrane. This is *Desmacidon*, a name in its Greek elements, differing little from the predecessor. And, indeed, the close alliance of the two genera may be seen by a classification of the special forms of spicules used, which fact I have noted in my paper on a new species of Raphiodesma.* One of the rarest and most beautiful of this genus is Desmacidon Rotalis (*Vide* Brit. Spongiadæ, Vol. iii). These three genera therefore make a natural group.

The next group takes us back again to the membrane, and the three genera comprised in it, are not the least interesting amongst British sponges. The first of these is called " *Hymeraphia*," another combination of terms previously used. It consists of a simple membrane and spicules lying upon it, not generally with much order, though occasionally in fasciculi, projecting through the dermal surface. But this extremely simple form of sponge commends itself by a variety of forms of spicules, not seen

* " Journal Q.M.C." Vol. vi., p. 97.

out of the genus, as far as my present knowledge goes, though it would be unsafe to lay this down as final. In that new species, which I had the pleasure of bringing to the notice of the Club, there is a new form of flesh spicule not hitherto seen (Journal, Vol. i., Ser. ii., p. 216). I direct your attention to *H. vermiculata* and *H. stellifera* (Brit. Spongiadæ, Vol. iii., Pl. xxvi, xxvii.), in illustration of foregoing remarks. Very closely allied to this, differing only in degree is *Hymedesmia*, a name again compounded of Greek elements previously used. It consists only of a basal membrane and a disjointed stratum of fasciculi of spicules. So closely are these allied, that it would be refining, perhaps, too much to place one before the other in organization. But the third of this allied group *Microciona* (*i.e.* small columns) certainly advances beyond the previous phases. In this there is a basal membrane upon which, a somewhat symmetrical arrangement of columns, formed of spicules, arises, and its most advanced example is *M. plumosa*, so called from its feather-like columns, making a pretty object under the microscope in sections, besides, being in detail, full of interest in its variety of spicules belonging to the membranes, &c. One of the genus is eccentric in its variations, and is known as *M. fictitia*. *M. Plumosa* is abundantly found on the shores of Tor Bay at low-water mark and in other parts of Devonshire, &c. I picked up a specimen of *M. fictitia* on the coast of Brighton: for a new species, found at Paighton, see "Journal Q.M.C." Vol. v., p. 1.

On the principle of development, I now take another group naturally connected together and belonging to the Keratosa. The sponge of Commerce so well represents this order, I omit here all reference to it, as also to British sponges directly in alliance with it. But there is one sponge, common enough on our south-eastern coast, which belongs to this order, yet shows a curious development, inasmuch as it strengthens its horny skeleton by the ingestion of grains of sand, fragments of spicules, and other extraneous substances. I may here observe, that sponges doing this are very numerous in different parts of the world, and I may give something of a monograph of them to the Club at some future time. This sponge, named for its ugliness "*Dysidea*," and specifically termed "*fragilis*," because sometimes, in its dried state, it is very brittle, though indeed you may find it also very tough, may be picked up abundantly at Brighton after a storm, and, found here, with fibres often very red, possibly from the red Algæ of this coast, gives instruction in the way in which it acts in taking up the particles of quartz, &c. I commend it to your notice, for, though ugly externally, a section by polarized light will display as much beauty as you can desire. The fibre will literally sparkle with gems. Next in our order comes "*Ophlitaspongia*," so called from being armed. It is an ordinary horny skeleton, upon which, externally, sharp acute spicules are developed, whether for defensive purposes, as has been suggested, or not, it is not possible for anyone to pronounce. Associated with its type form *O. seriata* is a tricurvate spicule.

The next allied form has one species which is to be constantly picked up on our southern coast. It is a branched sponge, one of the few to be recog.

nised by outward appearances. Nevertheless, an anatomical examination is necessary to understand its character. Its structure consists of fibres, somewhat symmetrically arranged to the long axis of the branches, connected by secondary fibres at right angles, making thus very defined channels. But this would not be sufficient to discriminate it, inasmuch as the next genus I shall speak of is similar, and, indeed, is very closely allied. Its name is "*Chalina*" (anchor), and its intimate structure shows us a horny fibre, within which spicules are developed in lines. In *C. oculata*, that which I refer to, the spicules are singly thus arranged, but in others they are more numerous. It sometimes shows the habit of taking up extraneous particles, such as spines of small echini, &c. I thus pass away from the horny sponge in these examples, which show a connection with the order, "Silicea," which connection in some foreign sponges is extremely curious, and much more developed.

Isodictya comes next; the name implies a similar or formal network. But, in this arrangement, it shares in some degree with the last genus. From this, however, it differs through the absence of keratose fibre, the spicular network being often formed of single spicules, attached at their terminal points by keratode. *I. simulans* being somewhat branched, allies itself in form with the last; so also do some species where the keratose matter on which the spicules of the skeleton lay, but not imbedded within it, is much developed. Indeed, the alliances of genera are often thus shown, where there is a departure from one type, at the beginning, and, at the end, where it may overlap or ally itself with another. In many of the membranes of this genus, the network is made up of single spicules in union with each other, and in the fibre the spicules may be so numerous as to simulate that of Desmacidon. Of all Dr. Bowerbank's genera this has the greatest number of species, viz., 70, and it naturally embraces the sponge in all its forms and characters. It is massive, or coating, parasitic, or self-contained. It is branched or amorphous, cup-like and fan-like, and in its natural condition of all kinds of colours. It abounds in almost every variety of spicule except the stellate, or forcipiform. It is sometimes very minute, and of British sponges it claims to have the largest in *I. palmata*. With the structure of this genus may be naturally associated the two British freshwater sponges; these, however, form a class by themselves, and have had special notices in our Journal.

I will now treat of the genus *Halichondria* (sea-bread), in which alliance may be found in the membranes of some of the *Hymeniacidon*, because of their reticulated structure, and some resemblances may also be seen in the last-described genus. *Halichondria*, however, as defined by Dr. Bowerbank, has a definitely constructed reticulation through the entire sponge, not confined to a particular part. The rete is multi-spicular, held together at the terminal portions of the spicule, and is generally well-defined. Two of this genus are exceedingly common, found almost on every shore, and both particularly characteristic. One is *H. panicea*, the bread-crumb of Ellis and of our early naturalists, and this is easily discovered by a hand magnifier, which will show the marked distinction of the

spicular network of its membrane, looking like a piece of lace, and it is within the area thus defined the pores may easily be seen. It is not, however, in the fresh state they can be so well observed. This sponge is very Protean in its form and colour, showing how little one can depend upon either character in this class. After a storm, I picked up at Teignmouth, fresh from the sea, one of olive green, another of orange, and another of yellow colour. It is found coating, or parasitic, sometimes very massive, but it is usually embracing portions of some small Algæ, and developing upon and enclosing them. *H. incrustans*—well so termed, for it is so often found upon shells or Algæ, or pieces of rock in crevices, preferring a shelter. It is in every way a most interesting sponge, having a somewhat more regular rete than that of "panicea," and rejoicing in a great variety of spicular forms. It is in this last particular a very useful sponge for the young student to study, and will prepare him for rarer species. The stellate spicule does not appear in this genus, though most of the other forms abound, and in great variety.

There is now a genus to be noticed as one to be generally distinguished by its outward branched form, and its stiff, rigid character. This will show it sufficiently, but its skeleton analysis is nevertheless required, especially in distinguishing species. Its name, *Dictyocylindrus*, implies a cylinder network. Long and stout acuate spicules, loosely compacted together, almost parallel to the axis of the branches, but diagonally making an indefinite rete, and not as in *Desmacidon*, making a multi-spicular solid fibre, is characteristic of the skeleton, in which are disposed at right angles small spined acuate spicules. Variations of the form of the long acuate spicules occur in different species, sometimes being very irregular and out of symmetry. *D. ramosus* is common and characteristic of the genus in outward form. *D. stuposus* and *D. fasciculosis* have each forms of stellate spicules, but no anchorate or other form of flesh spicule are found in any of the genus. Another genus, which stands by itself, and is to be generally known by its outward form, is *Polymastia* (many whips). It gets its name from, its surface displaying, sometimes in great numbers, projecting thong-like elevations, which seem to be flexible, and thus warrant the "scourge" term applied. But as in all cases in studying this class of organisms, the interest is in the intimate skeleton structure. This is composed of very compact columns of spicules, symmetrically formed, braced together by transverse fascicules, which sometimes very regularly cross at right angles to the columns, associated also with spicules, not so regularly arranged. In this there is an alliance in form with the beautiful *Euplectella aspergillum*, though, in this latter, there is no such separation of distinct spicules of the skeleton, the latter being anchylosed, as one might say, and which, perhaps, may take place during its growth.

The last group of siliceous sponges which require to be taken into consideration, are in close alliance with each other, not only in general character but in the details of spicular forms. These are *Geodia*, *Tethya*, *Pachymatisma*, and *Ecionemia*, and it is generally considered, that they have a higher claim in organization. The skeleton spicules, which constitute and build up

their structure, are different in most cases to those previously described. They are stout acerate forms, or large, with terminal trifid or triradiate arms, which last play a great part in *Geodia* and *Pachymatisma.* The last two, also, are similar in forming a hard crust on the outward surface, composed of globular spicules of silex, in the one case, ovate, which formed in the interior, seems to be ultimately collected on the dermis. In *Geodia* the triradiate headed spicules support this outer crust, over which, however, is a membrane with small stellate spicules, which also abound in the sarcode of the sponge (*vide* Brit. Spongiadeæ, Vol. i., Pl. xxviii.) *Tethya cranium* is a very compact mass of acerate spicules, radiating towards the outer surface, with trifid terminal spicules projecting through the dermis. Others of this genus indulge in large stellate spicules in the sarcode, but this particular species is noted for a curious and small sigmoid spicule, irregularly shaped. *Pachymatisma*, unlike the two last, whose outward form is either globular or sub-globular, is somewhat irregular in its massive character. It is, however, very distinctly allied to *Geodia* in the crust of ovate spicules of its dermal surface, which are likewise supported by a similar radiation of triradiate headed spicules, having long shafts with acerate terminals. Long acuate spicules are dispersed in its skeleton without much order in the reticulation. Its ovate spicule, and the absence of any stellate form, separate it from *Geodia* and *Tethya.* *Ecionemia* is allied to *Pachymatisma*, but has no such external rust. But as it is not a common form one may only remark upon one of its flesh spicules as being doliate, or barrel-shaped. Leaving the farther consideration of this and other less known forms to an advanced student, one may now pass the order, Silicea, for that, which Naturalists consider as the higher group of sponges, viz., the Calcarea.

None of the Calcarea, at least among British sponges, are found of a large size. Mostly they are very small, and are distinguished by the prevalence of the triradiate spicule in every genus, which form, though not absent, is rare amongst siliceous sponges. The first genus is *Grantia*, taking its name from Dr. Grant, an eminent worker in this department. Of this *Grantia compressa* has given the largest size. It derives its specific term from its compressed condition, as seen in the matured state; but in young examples you see no such character, and know it only by other details. The genus has a central channel or cloaca, by which its excreting system is distinguished. The walls of this, in *G. compressa*, besides triradiate spicules with long terminal shafts, has a remarkable clavate acuate spicule, its clavate end, bending at an obtuse angle, on the outward surface of the sponge; this will at once distinguish the species. *G. ciliata* is another interesting species; tube-like in shape, having its sides fringed with a series of ciliated apertures, and the same at the outfall of its cloaca. It is built up of triradiate spicules, but the ciliated forms are made up of long slender acerate spicules, tied together at their bases with another acerate form, short and stout. The young condition of this is not so generally simple in shape as it becomes when in a more developed condition.

Leucosolenia (*i.e.* white pipe), is a very interesting genus. It is formed of

numerous tubes, whose walls are made of triradiate spicules of one size only, braced by accerate spicules, sometimes of great proportionate length. The most remarkable form of this genus is *Leucosolenia lacunosa*, deriving its specific term from its numerous lacunæ. It grows upon a pedicel producing an ovate development; it is unique in character, and quite unmistakable when discovered. *L. contorta* is common, as it is found parasitic on small algæ; none the less is it to be esteemed by the student. *L. coriacea* is a creeping form, and in no way pipe or tube-like. The others are interesting, and conform to the character of the genus.

Leuconia is in structure divided from the last by its *not* having its triradate spicules of the same size. Indeed, the prevalence of large forms of this, particularly note it out for observation as a peculiarity. *L. nivea*, a coating form, is its essential type. Lastly, *Leucogypsia* (white earth) a small species, sessile, and not symmetrical, has its triradiate skeleton bound by short, strong, fusiform, accerate spicules, enough in itself to distinguish this from all its congeners. I have found it at Torquay (*L. Gossei*) amongst roots of Laminaria, the fertile source of so many species of various kinds, that have come into my hands. I therefore recommend the gathering of such when found encrusted with organisms, as a handy collector of relics of sea-life.

The student must be warned against certain objects often found, and which simulate the sponges. One of these is an ascidian forming a stellate crust of white colour. The ovisacs of one of the Natica have been mistaken, and may be again, for a sponge, as also the horny base which is seen with some of the zoophites, such as Antennularia. The spicules of sponges are well represented and described in Vol. i. of Dr. Bowerbank's "Spongiadæ," and the general forms of British sponges in Vols. iii. and iv. of that work.

The following objects were exhibited in the library:—

Diatom, *Bacillaria paradoxa* (living) ...	Mr. F. W. Andrew.
Foraminifera from the Red Chalk, Yorkshire...	Mr. G. Bailey.
Section of stem of Begonia	Mr. G. E. Mainland.
Lophopus	Mr. T. J. McManis.
Diatoms, *Triceratium decangulatum*, &c. ...	Mr. H. Morland.
,, *Aulacodiscus Hartianus*	Mr. E. M. Nelson.
Limnias	Mr. C. Le Pelley.
Sponge, *Geodia Barrettii*	Mr. B. W. Priest.
Volcanic ash from Langdale Pike	Mr. G. Smith.
Felsite from Canock Fell	,, ,,
Diatom, *Actinogonium septenarium*. Var. ...	Mr. G. Sturt.
Spirogyra orbicularia, in conjugation... ...	Mr. J. J. Vezey.
Sponges, various...	Mr. J. G. Waller.
Cordylophora lacustris	Mr. A. Weldy.

Attendance—Members, 63; Visitors, 10.

February 22nd, 1884.—Ordinary Meeting.

Dr. M. C. Cooke, M.A., A.L.S., President, in the Chair.

The minutes of the preceding meeting were read and confirmed.

The following gentlemen were balloted for and duly elected members of the Club:—Mr. James Epps, Jun., Mr. Alfred V. Jennings, Mr. Fredk. W. Kell, Mr. Frank Steele and Mr. George McCrie.

The following donations to the Club were announced:—

"Journal of the Royal Microscopical Society"	From the Society.
"Science Gossip"	" Publisher.
"Science Monthly"	In Exchange.
"The Midland Naturalist"	From the Editor.
"Annals and Proceedings of the Belgian Microscopical Society"	" Society.
"Canadian Government Survey"	" Department.
"American Monthly Microscopical Journal"...	In Exchange.
"Journal of Botany"	From Mr. T. C. White.
"Quarterly Journal of Microscopical Science"	Purchased.
"Annals of Natural History"...	"
"Cole's Studies"	"
"Northcot's Handbook of the Microscope," 1859	From Mr. F. Crisp.
One Slide...	" Mr. Freeman.

The thanks of the meeting were voted to the donors.

Mr. G. C. Karop exhibited and described Cathcart's Ether Microtome, which he thought supplied the want of a cheap, yet well-made, machine for freezing and cutting fresh tissues.

Mr. Buffham read a paper "On the Florideæ and on some newly found Antheridia," the subject being illustrated by a series of coloured diagrams.

The President said he should like to call attention and to correct an impression which otherwise might possibly be made, that Mr. Buffham did not appreciate to the full extent the labours of Professor Harvey, in his references to the "Phycologia Britannica." He thought it could not have been intended to convey such an impression, but, for fear any such idea might have been given, it would be well just to remove it as far as possible. It should be remembered that the greater part of Professor Harvey's work was done half a century ago, and before the Phycologia was published; but taking the Phycologia as it was, he did not hesitate to say that it was not only the best they had in England, but that it was equal to anything of the kind which had appeared on the Continent, and that whilst it was no doubt behind what had been done in 1884, it was rather in advance than otherwise of the time when it first made its appearance. Personally he had an affection for Professor Harvey, whose kindly ways he well remembered, who was always ready to lend a helping hand to the enquiring student, and who did not think it was derogatory to do so, whilst there were some who seemed to think that they should reserve all their force for

the benefit of those who were as well able to find out things for themselves, He was unwilling, therefore, that anyone should go away from the meeting with a wrong impression. No doubt his remarks would draw from the author of the paper a repudiation of any idea of underrating the work of Professor Harvey, though in these days of rapid progress they were sometimes apt to look upon the work done half a century ago and to think how incomplete it was, forgetting that the microscope in those days was not so common, or so cheap, or so good as at present. The paper was a very excellent one, and he could certainly congratulate the Club upon having had it brought before them.

Mr. Goodwin asked if Mr. Buffham had been in the habit of cultivating his algæ in an aquarium, and if so whether he would say if he had found any difficulty in doing so?

The President said that in looking over the Phycologia he noticed that Harvey said he had been very successful in cultivating some marine algæ in closed bottles of sea water.

Mr. Buffham said with regard to the cultivation of algæ he did not think it would be possible to do so successfully; if it was it would enable them to clear up many interesting points which were at present doubtful. He hastened with pleasure to refer to the remarks of the President, and to say that if he had said anything in any way disparagingly of Professor Harvey, or which would appear to convey the impression that such was the case, he would carefully revise the proof of the paper and would take care that no such impression remained. He scarcely thought, however, that they would think him guilty of such a thing. He should only desire to speak in the most unqualified terms of admiration as to the labour, care, beauty of the drawings, and in every way whatever of the splendid work which he was glad to say had a place in their library. He was himself, he might say, only a beginner, for having determined in a desultory way some years ago to try and do something in the way of marine algæ it became necessary for him to obtain what information he could from books on the subject. He found that the Phycologia had come into their library and he borrowed it, and had done so repeatedly since; indeed, he did not know how anyone could begin without becoming acquainted with what Professor Harvey had done. He soon found that Harvey had endeavoured to depict all the species then known, but in the course of his own collecting he had come across specimens which were not found in "Harvey," and in his desire to follow up the matter he was encouraged to go on by Mr. Holmes. He then found that in order to know what had been done already a great deal of research was necessary, not only amongst English writers, and also those who had done anything abroad; and on this point he should like to ask the President if he knew of anything else done in England on the lines he had attempted to follow, that of endeavouring to present those forms which had not been figured by Harvey? He hoped that these observations would have the effect of re-assuring the President, and that he would now be able to go home and enjoy a good night's rest.

The President said he did not at all regret the remarks he had made

seeing that they had been the means of producing not only the further excellent remarks from Mr. Buffham, but also the full, clear and distinct avowal of the absence of any feeling which might otherwise have been thought to be present. He did not himself think that it was, but still it might just possibly have been thought so by others, and perhaps have led someone to consider what a very deficient work Harvey's was after all, whereas he did not know a botanist anywhere whose work had been more carefully or conscientiously done than that of Professor Harvey. He, therefore, would ask the meeting now to give a hearty vote of thanks to Mr. Buffham for his very interesting paper—he could only feel that it was a cause of great regret that papers of that sort were so few and far between. He thought also, that those of them who had been anxious to increase their library by the addition of such books as these would be encouraged to know, that in this instance at least, such good results had followed, and he would express a hope that the example set would lead to similar results in other directions, and that other members would be moved to take up other studies at the points where someone else had laid them down. As regarded books on this subject there was no work in English, either here or in America, on the Florideæ, but there had been many in French. Books, however, now-a-days multiplied so rapidly that he could not keep pace with them, and it was in consequence often more pleasure to him to shirk a book than to dip into it.

A vote of thanks to Mr. Buffham was unanimously carried.

Announcements of Meetings, &c., for the ensuing month were then made, and the meeting terminated with the usual conversazione, when the following objects were exhibited:—

Various slides illustrative of his paper ...	Mr. T. H. Buffham.
Group of *Acinetæ*	Mr. W. G. Cocks.
Podophrya quadripartita	" "
Long. sec. Grain of Maize	Mr. J. Cole.
Cockroach, *Periplaneta Germanica*	Mr. H. E. Freeman.
Hoplophora contractilis...	Mr. H. R. Gregory.
Casts of Foraminifera, &c., from Calcareous Sandstone from Bombay	Mr. H. F. Hailes.
Fibro-cells of Orchid, *Oncidium bicallosum* ...	Mr. G. E. Mainland.
Arcturus longicornis	Mr. A. D. Michael.
Section of leaf, *Abies subalpina*	Mr. J. W. Reed.
Trans. sec. spinal cord of Calf...	Mr. F. Steele.
Living eggs of *Limnæa auricularis*	Mr. A. W. Stokes.
Diatoms, *Aulacodiscus Petersii*	Mr. G. Sturt.
Mercurous Chloride	Mr. H. J. Waddington.

Attendance—Members, 63; Visitors, 4.

March 14th, 1884.—Conversational Meeting.

The fourth demonstration of the second series was given by Mr. E. M. Nelson, the subject being "How to work with the microscope."

He began his subject by a short description of the instrument. He advocated the simple tripod as being the lightest and at the same time the most steady form of stand. He noticed the tendency there was to shorten the spread given to the legs, which made the instrument more portable, but at the expense of steadiness. He said that microscopes might be divided broadly into two classes, viz., the bar-movement and the Jackson-Lister. In point of steadiness he did not think there was much to choose between them in first-class stands. As the bar-movement was the more difficult and expensive to make properly, in many instances the work would be found to have been scamped, and shaky instruments would be the result. When carefully made the bar-movement was as steady as the Jackson-Lister, and had the decided advantage of giving plenty of room on the stage. Unless a Jackson-Lister were made enormously large and heavy the complete rotation of an ordinary mechanical stage was impossible. The thin stages with pinions on the top, which have been made, both here and in America, to obviate this difficulty, have introduced fresh elements of unsteadiness, errors far worse than the one they were intended to correct.

Until quite lately it may be said that there was no Jackson-Lister which had a satisfactory fine adjustment. Every one will know the common model, with the abominable little lever at the side of the nose piece. When delicate focussing was required one was always obliged to give up the fine in preference to the coarse adjustment. That this objection was really felt is evident from the number of appliances that have been invented to get over the difficulty. He only alluded to one, which was probably the most common, viz., the plan of cutting the solid Jackson-Lister arm, and putting the body, coarse adjustment, rackwork, pinion, etc., on the fine adjustment lever. It is only necessary to say that when the solid arm is cut the special point of the Jackson-Lister model is lost, and the instrument at once placed far below the bar-movement in efficiency. Messrs. Swift and Son were the first to rescue the Jackson-Lister model from its unfortunate position, by the invention of the vertical lever movement. This was a great stride in the right direction, not so much on account of the vertical lever itself, but because it did away with the necessity for an accurate fitting to the movable nose piece. This fitting is left loose, the movement being steadied by a bar in guides, which can be adjusted at pleasure by two screws, without taking anything to pieces. This fine-adjustment has the slowest motion, is the steadiest, and at the same time is the strongest that has been yet made. With regard to Continental models they may be considered as Jackson-Listers, with cut arms placed on direct acting screw fine-adjustments. They are not equal in efficiency to those which have the cut arms, and whose fine-adjustments have been geared down by the interposition of a lever. It may be accepted as an axiom that no direct acting screw fine-adjustment is slow enough for the

wide angled oil immersion glasses of the present day. In his experience he thought the bar-movement as made by Powell and Lealand the best, and found it capable of doing everything that any other instrument would do. Passing on he mentioned that an instrument could only be called a microscope which had a mechanical centring and focussing substage condenser; those without this apparatus might be termed magnifying glasses. With regard to object-glasses he considered that four only were necessary to form a complete battery, viz., $1\frac{1}{2}$ inch N.A. ·17, $\frac{2}{3}$, N.A. ·39, $\frac{1}{6}$, N.A. ·82, and a $\frac{1}{12}$ N.A. 1·43. A beginner might get a $1\frac{1}{2}$ and a $\frac{2}{3}$, or a medical student a $\frac{2}{3}$ and $\frac{1}{6}$. In either case the series can be made complete by the addition of other glasses. Much money is wasted in buying glasses which, as the student advances in knowledge and experience, have to be sold at a loss to make room for others to perfect the battery. Anyone going in for fancy work might add to the above series a 3-inch N.A. ·08a $\frac{1}{3}$, N.A. ·77, and a $\frac{1}{25}$ N.A. 1·38. In respect of the proper aperture that ought to be given to objectives, he referred to a paper he had already communicated to the Club, in which he had stated, that a theoretically perfect lens ought to have sufficient aperture given it to enable it to resolve anything that was capable of being appreciated by the eye, with a magnification of ten times the initial magnifying power of the lens, the visual angle for *definition* being taken at 1′·23″ (250 lines to the inch at 10 inches). Example:—The eye, assisted by a magnification of 400 diamaters (= the initial magnification of a $\frac{1}{4} \times 10$), could perceive with the above visual angle 100,000 lines to the inch at 10 inches (*i.e.*, 250×400), provided the $\frac{1}{4}$ had a numerical aperture of 1·04, so as to be capable of resolving them. Therefore a $\frac{1}{4}$, to be a theoretically perfect lens, ought to have a numerical aperture of 1·04, otherwise all that is capable of being seen will not be resolved; in other words, all the details of any object will not have the greatest amount of perceptible sharpness. As to eye-pieces, he feared that the Huygenian formula was not strictly adhered to in many instances. The curve of the field glass was often too shallow. He did not approve of the plan of stopping off a large portion of the field by a diaphragm. A 2 inch, 1 inch, and $\frac{1}{2}$ inch would form a complete battery of eye-pieces, the first two being for work, and the last for adjusting the object glass and testing purposes. He would not recommend the $1\frac{1}{2}$ inch except where only one eye-piece was allowed, and he deprecated the use of Kellner's altogether.

With respect to condensers he said that it was not sufficiently realised that the power and aperture of the condenser ought to bear a certain relation to the power and aperture of the objective. He considered the best condenser for use with a $\frac{1}{6}$ and upwards was the achromatic by Powell and Lealand. It had a numerical aperture of 1·0, was perfectly achromatic, and had a very long focus, in fact, no critical work with high powers could be done without it. For lower powers that of Swift and Son was excellent. The top lens was removable, so that its range could be expanded from a 3 inch to a $\frac{1}{6}$ or dry $\frac{1}{8}$. This condenser gave with low powers the best dark field known, and when used with the ground glass gave splendid effects with transmitted light. The equipment of a microscope was not complete

without both these condensers. He did not advise the use of chromatic condensers, except with oblique light. Paraboloids and spot lenses might be regarded as altogether out of date, being quite superseded by condensers.

Diffused daylight was suitable for low powers up to a $\frac{2}{3}$, a concave mirror ground glass, and a diaphragm being used. A great falling off in sharpness would be experienced with powers higher than a $\frac{2}{3}$, unless a condenser were used; even then daylight was so uncertain that it was impossible to test objectives by it, that is to say, the best picture an objective is capable of producing cannot be obtained by daylight. Sunlight from a heliostat, used obliquely, gives the strongest resolutions known. For general work he recommended the light from a common paraffin lamp with a $\frac{1}{2}$ inch wick. In the case of transmitted light the picture is that of *the source of light interrupted by the object;* it is, therefore, of the first importance that the light should be as pure as possible. Pure light, with the ordinary lamp chimney, is hardly practicable. The flame being more or less distorted by the specks, striæ, and irregularities in the curvature of the glass, as well as by the reflections from the inner surface of the chimney. To obviate this he had a metal chimney made by Swift, blackened inside, the glass part being an ordinary 3×1 slip. He then insisted that if the finest results were wanted, it was absolutely necessary to focus, by means of the condenser, the image of the source of light on to the object, keeping the condenser accurately centred to, and the direction of the illuminating beam in, the optic axis. It was of no importance whether the light came from the lamp direct, or was reflected from the plain mirror, provided that there were no secondary reflections. Secondary reflections in a plain mirror could be got rid of by rotating the mirror in its cell. For direct transmitted light he considered that from a paraffin lamp with a $\frac{1}{2}$-inch wick the best, and it would give enough intensity for all ordinary resolutions with oblique light; but for special resolutions a lamp with a larger wick, lime light, or electric arc lamp might be used. The incandescent lamp for microscopical purposes was quite useless. It was not intense enough for oblique light, and for direct light the image of an incandescent filament was not suitable to view an object in. For low power work a larger surface would be required to be illuminated than that covered by the edge of the flame. The best way, he thought, of doing this was to expand the image of the flame into a disc by means of a bull's eye. The bull's eye, like the condenser, must be accurately focussed and centred on the edge of the flame. Those blue patches and irregularities of illumination which so often troubled microscopists were due to not taking sufficient care in focussing and centring the bull's eye. The intensity of the light was regulated by the angle of the bull's eye. Mr. Swift made one for him on Herschel's formula, viz., a meniscus and a biconvex, a form long used in first-class magic-lanterns. It has the advantage that by taking away the meniscus the focal length of the bull's eye was increased, and its intensity greatly diminished. Great intensity would be required in crossing difficult diatoms with a double slot, whereas an object such as a heliopelta, with a $\frac{2}{3}$, would be better seen with less intensity. The lamp with the bull's eye is

useful for the following kinds of illumination :—1. Oblique with double slot. 2. Dark ground with central stop. 3. Transmitted light with ground glass for low powers. 4. Lieberkuhns. 5. Polarised light with low powers. He did not recommend the bull's eye for critical work with transmitted light, such as testing object glasses, nor with oblique light with single slot; the simple edge of the flame without any bull's eye being far better. In dark ground illumination, the lower the power of the objective the larger would be the field that would have to be illuminated, consequently the larger the disc ought to be. The size of the disc can be regulated by approaching or removing the lamp, with the bull's eye attached, to or from the condenser. The bull's eye ought always to be fixed to the lamp *itself*, and not be on a separate stand, or even move independently on the same stand.

Diaphragms, he said, were elements of the greatest importance to the critical microscopist. The ordinary wheel of diaphragms, if carefully made so that the apertures were all centred, was very convenient. The apertures could be rapidly changed, and the effects could be exactly reproduced by using the same aperture. Another plan was to have a disc holder fastened below the condenser, and made so that it could be turned on one side to allow the discs to be changed. This plan permits of easy centring, also the exact reproduction of the effects; its disadvantage is that it is slow. An iris diaphragm is the most rapid, as well as true in centring, but one can never be sure of reproducing the same effects. Therefore, while it is the best for ordinary work, it can hardly be considered suitable for testing object glasses, where the exact reproduction of the illuminating conditions is absolutely essential. He then explained, by means of diagrams, the various methods of using stops, slots, etc., and the consequent results in the images at the backs of the objectives. The lieberkuhn, he thought, was the best illumination for opaque objects, with low powers. Excellent results could be got by it with a $\frac{1}{4}$ of 100°. It was unfortunate that many opaque objects were mounted on slides either covered up with paper, or on opalescent glass slips, so that the lieberkuhn could not be used. Side and parabolic reflectors ought always to be fitted to a part of the stand, and not, as is usually the case, either to the objective, or nose piece, or movable part of the stage. The reason for this is that when the light has been once arranged it is not disturbed by moving the object, or changing the object glass. He next showed how very delicate measurements could be made by having the screw micrometer mounted on a separate stand. He recommended the fixed wire to be placed five revolutions of the screw to one side, instead of in the centre, of the field, where it is always found. The wire, he said, could not be too fine. The separate stand could be of the ordinary bull's-eye condenser form, but the circular foot ought to rest on three points only. With such an instrument he had passed the movable wire over, and counted 100 striæ on an A. Pellucida, which had 96 striæ in the $\frac{1}{1000}$ of an inch. As to drawing, he fully endorsed what Mr. Hardy had said at a previous demonstration, with regard to Beale's neutral tint. With this simple appliance he had outlined delicate objects, under a magnification of 2,500 diameters, without difficulty. He regretted that time did not permit him

to demonstrate the method of using the polariscope with the highest powers. In conclusion, he drew their attention to some diagrams illustrating the various accepted views of the markings in the diatomaceæ. One diagram showed those on the *P. Formosum*, passing from simple striæ to white dots, next to black dots, thence to squares, which he regarded as the true picture. He impressed on all who wished to carry on investigations in this line, to focus, and adjust on the silex itself, and let the markings take care of themselves. He acknowledged that it was a matter of no little difficulty, but with time and patience the eye would become educated up to it. After the demonstration, the proboscis of a blow fly was shown on a Powell and Lealand No. 1 stand, Wenham binocular, and 1 inch Powell and Lealand objective (1857); also a *P. Formosum*, showing "squares," on a Jackson-Lister by Swift, with $\frac{1}{12}$ by A. Ross, upwards of 30 years old. The various pieces of apparatus, upon which Mr Nelson had commented, were on the table.

The following objects were exhibited in the library:—

Spores of Quillwort (*Isoetes*)	Mr. F. W. Andrew.
Anthrax (*Bacilli*) in spleen, from a case of splenic fever	Mr. W. I. Curties.
Crystals of Theobromine	Mr. J. Epps, Junr.
Dipterous larva, sp.	Mr. H. E. Freeman.
Sand from Salt Lake	Mr. H. G. Glasspoole.
Leptus autumnalis	Mr. H. R. Gregory.
Lepidocyrtus curvicollis...	Mr. G. E. Mainland.
Epistylis	Mr. C. Le Pelley.
Lophopus crystallinus	" "
Actinophrys Eichhornii...	Mr. C. Rousselet.
Photographs of Salicine, taken by ordinary, and by polarized light	Mr. G. Smith.
" " Lava, from Eifel, by polarized light	" "
" " Trachyte, from the Rhine, by polarized light ...	" "
" " Andesite, by polarized light ...	" "
L. S. Fang of molar tooth, showing *dentine* and *crusta petrosa*	Mr. F. Steele.
Section of Kidney (Human)	" "
Diatom, *Triceratium Hardmannianum* ...	Mr. G. Sturt.

Attendance—Members, 88; Visitors, 13.

March 28th, 1884.—Ordinary Meeting.

Dr. M. C. Cooke, M.A., A.L.S., President, in the Chair.

The Secretary read the minutes of the preceding meeting, which were confirmed and signed by the President.

Mr. Arthur Beetham was balloted for and duly elected a member of the Club.

The following donations were announced:—

"Proceedings of the Geologists' Association"	From the Association.
"Science Gossip"	,, ,, Publisher.
Cole's "Studies in Microscopical Science" ...	Purchased.
Dr. Cooke's "Fresh Water Algæ," part 7 ...	,, ,,
"Annals of Natural History"	,, ,,
"Proceedings of the Belgian Microscopical Society"	From the Society.
"The Microscope"	,, ,, Editor.
"American Monthly Microscopical Journal"...	In Exchange.
"The Analyst"	From the Editor.
Reprint of a Paper "On the occurrence of Bacteriæ and Bacilli in living plants	,, Dr. Ralph.

The thanks of the meeting were voted to the donors.

Mr. Ingpen said that Dr. Ralph's paper had particular reference to what he had found upon the Australian *Vallisneria*, a specimen of which it would be remembered was presented to the Club by Dr. Ralph some time ago. This was still living, and he had examined the leaves to see if he could find any Bacilli upon them. On the healthy leaves he was only able to discover a few, but on those which were dying they were tolerably numerous. This Vallisneria, it would be remembered, grew under favourable circumstances to a length of five or six feet. The power he used in order to see the Bacilli was a $\frac{1}{8}$in. They were not so large as *Bacillus Tuberculosis.*

Mr. Hardy suggested that some off-shoots from this Vallisneria should be placed in the tank of the Botanic Society at Regent's Park, where the conditions would no doubt favour its development.

Mr E. M. Nelson said he had received on the previous Saturday a beautiful packet of diatoms from Professor Hamilton Smith, mounted in his new medium, having a refractive index of 2·4. Some of them had gone bad, but he was able to find some specimens fit for examination, and had resolved them perfectly with a $\frac{1}{12}$ $\frac{1}{8}$, and $\frac{1}{4}$ object glass, also with an old $\frac{1}{12}$in. made many years ago, and having an angle equal to 141° in the air. He also wished to mention that he had found that the Tubercle Bacillus was to be very well seen by dark ground illumination—it took the light very strongly, and gave the appearance of grains of gold on black velvet. This mode of illumination saved the eyes from the woful glare of the direct light, and also enabled the objects to be much more easily detected.

Mr. Ingpen enquired in what way these objects could be stained ?

Mr. Nelson said that the ordinary staining by Dr. Gibbe's method answered very well. Those specimens which he had exhibited were stained in that way.

Mr. J. G. Waller read a paper "On Parasitic Vegetable Organisms in Calcareous Particles of the Gabbard Sands," the subject being illustrated by numerous coloured diagrams.

The President said he was sure the members must have listened with much interest to the paper, and he must for himself express his personal thanks to Mr. Waller for having brought the matter so clearly before them. So far as his own reading went with regard to the excavating bodies referred to, he could only say that heretofore he felt far from satisfied with the arguments and examples produced, but now he thought there was rather more on which to form an opinion, although previously it had been doubtful as to whether they were algæ or fungi. He thought, however, that Mr. Waller was right in assuming that they showed more affinity to the fungi than to the algæ, and that they were not far removed from the group in which it was proposed to place them. One correction he would like to suggest, and that was wherever Mr. Waller mentioned *asci*, this term should be struck out and *Sporangia* put in the place of it. The former would be sacs enclosed within the peridium, but *Sporangia*—vessels containing spores—was the right term. As regarded Fig. 20, he did not think it had such affinity to *Villosæ*, but would suggest that it seemed to come nearer to the *Mucorini*. They all reminded him very much of the parasite commonly known as the Fungus Foot of India, in which they had an example of a parasitic mucor. He considered that Mr. Waller had done good service in bringing the subject before them.

A vote of thanks to Mr. Waller was unanimously passed.

Mr. Waller, in acknowledging the vote of thanks, said that he confessed himself to be a complete novice on this subject, but it had been his intention when he brought it forward to draw out information on it, and he knew that there was no one so likely to be able to impart this as their President himself. There was a very great deal yet to be learnt upon the subject.

The President read a letter from the Secretary of the Ealing Microscopical Society announcing their arrangements for a soirée to be held on April 30th, and inviting the co-operation of members of the Club on that occasion.

The proceedings then terminated with the usual conversazione, when the following objects were exhibited:—

Spongilla fluviatilis	Mr. F. W. Andrew.
Section of White Marble, by polarized light...	Mr. A. L. Corbett.
Wheels of *Chirodota*	Mr. W. I. Curties.
Tubercle bacillus, in sputum, and in tissue, shown on a dark ground with $\frac{1}{2}$in. and $\frac{4}{10}$in. objectives	Mr. E. M. Nelson.
Gonium pectorale	Mr. C. Le Pelley.
Stentor polymorphus	Mr. C. Rousselet.
Pikrite Schreisheim	Mr. G. Smith.
Adipose tissue	Mr F. Steele.
Œcistes crystallinus	Mr. A. Wildy.

Attendance—Members, 73; Visitors, 7.

Q.M.C. EXCURSION.

List of Objects Found at Keston by Messrs. Badcock, Bartlett, and Cox, Dr. M. C. Cooke, Messrs. Dadswell, Funston, Hardy, Mainland, J. T. Powell, and Rousselet.

April 5th, 1884.

Batrachospermum moniliforme.
Drapernaldia plumosa.
Chætophora elegans.
Stigeoclonium elongatum.
Spirogyra condensata, var. *varians.*
Zygnema cruciata } and others.
" *stagnalis* }
Mesocarpus sp. (perhaps *pleurocarpus*).
Vaucheria sessilis.
Volvox globator, and another.

Closterium acerosum.
" *lunula.*
" *moniliferum.*
" *setaceum.*
" *striolatum.*
Cosmarium margaritiferum.
" *crenatum.*
" *Ralfsii.*
Euastrum didelta.
" *oblongum.*
Micrasterias denticulata.
" *rotata.*
? *Spirotænia* sp.
Xanthidium.
Navicula }
Nitzschia variola } and other diatoms.
Pinnularia nobilis }
Surirella bifrons }

Æcidium ari.
,, *ranunculacearum.*
Mitrula paludosa.
Puccinea malvacearum.
Ramularia Lamii.
Uredo confluens.

Actinophrys Eichhornii.
,, *sol.*
Anthophysa vegetans.
Bursaria truncatella.
Chætonotus larus.
Difflugia proteiformis.
Dileptus folium.
Dinobryon sertularia.
Euglena acus.
Paramecium.
Stylonichia mytilus.
Trachelocerca olor.

Conochilus volvox.
Eosphora aurita.

ROTIFERS ON *chætophora elegans.*

Floscularia coronata.
Hydatina senta.
Mastigocerca carinata.
Monocera rattus.
Pterodina patina.
Rattulus lunaris.
Rotifer vulgaris.
Salpina sp.
Tardigrada.

Cyclops signatus.
Chydorus sphericus.
Daphnia pulex.
Eurycercus lamellatus.
Cypris minutus.
Hydra viridis.
Planaria ?

Free Nematoids.

Larva of *Tanapus maculata.*

The following plants were also found :

Corydalis claviculata.

Vaccinum myrtillus, and more than thirty common species of flowering plants.

Sphagnum.

Drosera.

Mr. Badcock says that *Batrachospermum* was not to be found, as is usually the case, in Cæsar's Well, but was found in large masses at the *bottom* of the pond below the well. The rotifers on *Chæto-phora* were very peculiar, and he was not able to identify them.

There were about forty persons out on the Excursion, of whom at least twenty-five were members of the Quekett Microscopical Club.

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OFFICERS AND COMMITTEE.

(Elected July, 1882.)

President.

M. C. Cooke, M.A., LL.D., A.L.S.

Vice-Presidents.

T. S. Cobbold, M.D., F.R.S., &c.
Hildebrand Ramsden, M.A., F.L.S., &c.
Charles Stewart, M.R.C.S., F.L.S., F.R.M.S.
T. Charters White, M.R.C.S., L.D.S., &c.

Committee.

W. H. Gilburt, F.R.M.S.
A. D. Michael, F.L.S., F.R.M.S., &c.
E. T. Newton, F.G.S.
W. W. Reeves, F.R.M.S.
J. Matthews, M.D., F.R.M.S.
B. W. Priest.
J. G. Waller.
J. W. Groves, F.R.M.S.
J. D. Hardy.
E. Jaques, B.A., F.R.M.S.
E. M. Nelson.
W. J. Scofield, M.R.C.S., F.L.S.

Hon. Treasurer.

F. W. Gay, F.R.M.S., 113, High Holborn, W.C.

Hon. Secretary.

J. E. Ingpen, F.R.M.S., 7, The Hill, Putney, S.W.

Hon. Secretary for Foreign Correspondence.

H. F. Hailes, 5, Richmond Villas, Middle Lane, Crouch End, N.

Hon. Reporter.

Richard T. Lewis, F.R.M.S.

Hon. Librarian.

Alpheus Smith.

Hon. Curator.

Charles Emery.

Excursion Committee.

W. G. Cocks.
Edward Dadswell.
F. W. Gay, F.R.M.S.
Frederick Oxley, F.R.M.S.
W. W. Reeves, F.R.M.S.
T. Rogers, F.L.S., F.R.M.S.
James Spencer, F.R.M.S.

PAST PRESIDENTS.

	Elected
EDWIN LANKESTER, M.D., F.R.S. - -	July, 1865.
ERNEST HART - - - - - -	„ 1866.
ARTHUR E. DURHAM, F.R.C.S., F.L.S., &c.	„ 1867.
„ „ „ - -	„ 1868.
PETER LE NEVE FOSTER, M.A. - -	„ 1869.
LIONEL S. BEALE, M.B., F.R.S., &c. -	„ 1870.
„ „ „ - -	„ 1871.
ROBERT BRAITHWAITE, M.D., F.L.S., &c.	„ 1872.
„ „ „ - -	„ 1873.
JOHN MATTHEWS, M.D., F.R.M.S. - -	„ 1874.
„ „ „ - -	„ 1875.
HENRY LEE, F.L.S., F.G.S., F.R.M.S., F.Z.S.	„ 1876.
„ „ „ - -	„ 1877.
THOS. H. HUXLEY, LL.D., F.R.S., &c. -	„ 1878.
T. SPENCER COBBOLD, M.D., F.R.S., F.L.S., &c.	„ 1879.
T. CHARTERS WHITE, M.R.C.S., F.L.S., &c., &c.	„ 1880.
„ „ „ - -	„ 1881.

HONORARY MEMBERS.

Date of Election.	
Jan. 24, 1868.	Arthur Mead Edwards, M.D., 120, Belleville avenue, Newark, New Jersey, U.S.A.
Mar. 19, 1869.	The Rev. E. C. Bolles, Salem, Mass., U.S.A.
July 26, 1872.	S. O. Lindberg, M.D., Professor of Botany, University of Helsingfors, Finland.
July 26, 1872.	Prof. Hamilton L. Smith, President of Hobart College, Geneva, New York, U.S.A.
July 26, 1872.	J. J. Woodward, Assist. Surgeon, U.S. Army, War Department, Surgeon General's Office, Washington, U.S.A.
July 23, 1875.	Lionel S. Beale, M.B., F.R.S., F.R.M.S., &c. (*Past President Q.M.C.*), 61, Grosvenor street, W.
Sept. 22, 1876.	Frederick Kitton, Hon., F.R.M.S., &c., 2, Bedford street, Unthank road, Norwich.
July 25, 1879.	W. B. Carpenter, C.B., M.D., F.R.S., &c., &c., 56, Regent's park road, N.W.
July 25, 1879.	Dr. E. Abbe, University, Jena, Saxe Weimer, Germany.
July 23, 1880.	F. H. Wenham, C.E., 3, Gothic Villas, Warbeck road, Shepherd's Bush, W.

LIST OF MEMBERS.

Date of Election.	
Sept. 24, 1869.	Ackland, William, L.S.A., F.R.M.S., 416, Strand, W.C.
June 25, 1880.	Adams, C. A., 33, Loughborough park, Brixton, S.W.
Nov. 28, 1879.	Adams, S. C., 65, Blomfield road, Maida hill, W.
June 23, 1876.	Addis, W., 44, Herbert street, New North road, Hoxton, N.
Nov. 27, 1868.	Adkins, William, 268, Oxford street, W.
June 24, 1881.	Alabone, E. W., M.D., 175, Highbury New park, N.
Mar. 23, 1866.	Allbon, William, F.R.M.S., 37, Gloucester place, Portman square, W.
April 25, 1879.	Allen, E. H., 17, Carlisle street, Soho square, W.
June 23, 1876.	Allison, Charles, 71, Graham road, Dalston, E.
July 26, 1872.	Alstone, John, 3, Great Tower street, E.C.
Dec. 17, 1869.	Ames, G. A., F.R.M.S., Union Club, Trafalgar square, W.C.
Sept. 25, 1868.	Andrew, A. R., 1, St. George's villas, Middleton road, Hornsey, N.
Dec. 22, 1865.	Andrew, F. W., 3, Neville terrace, Onslow gardens, S.W.
Aug. 22, 1879.	Arch, A. J. E., 20, Sydenham park, S.E.
May 28, 1875.	Arrowsmith, Wastell, 99, Adelaide road, Haverstock hill, N.W.
July 25, 1879.	Ashbridge, Arthur, 76, Leadenhall street, E.C.
Sept. 27, 1878.	Ashby, H. T., 8, Bartholomew road, Kentish town, N.W.
Dec. 22, 1865.	Atkinson, John, 33, Brook street, W.
July 23, 1875.	Ayling, J. J., 47, Chantry road, Stockwell, S.W.
June 26, 1874.	Badcock, John, F.R.M.S., 270, Victoria park road, South Hackney, E.
Dec. 27, 1867.	Bailey, J. W., 75, Broke road, Dalston, E.

Date of Election.	
April 24, 1868.	Baker, Charles, F.R.M.S., 244, High Holborn, W.C.
May 25, 1877.	Baker, G. L., 15, Windsor road, Denmark hill, S.E.
Feb. 25, 1876.	Ballard, Dr. W. R., jun., 26, Manchester square, W.
Jan. 24, 1879.	Barham, G. T., Danehurst, Hampstead, N.W.
July 28, 1876.	Barnard, Henry.
Dec. 27, 1872.	Barnard, Herbert, 33, Portland place, W.
April 22, 1870.	Barnes, C. B., 4, Egremont villas, White horse lane, South Norwood, S.E.
Aug. 28, 1874.	Barnett, E.W.
Sept. 27, 1872.	Bartlett, Edward, jun., L.D.S., M.R.C.S.E., 40, Elgin road, St. Peter's park, W.
Oct. 26, 1877.	Basevi, Col. G. H., Elm lodge, Prestbury, Cheltenham.
Dec. 28. 1877.	Batchelor, J. A., Avenue road, Bexley, Kent.
May 22, 1874.	Bate, G. P., M.D., F.R.C.S.E., F.R.M.S., 412, Bethnal green road, E.
Mar. 27, 1874.	Beach, R. J., 36, Eden grove, Hornsey, N.
Jan. 25, 1878.	Beaman, G. H.
May 28, 1869.	Bean, C. E., Brooklyn house, Goldhawk road, Shepherd's bush, W.
Feb. 28, 1879.	Bear, John.
Nov. 26, 1875.	Beaulah, John, Raventhorpe, Brigg.
May 24, 1878.	Beddard, F. E., New College, Oxford.
May 26, 1871.	Bedwell, F. A., M.A. Cantab., F.R.M.S., Fort Hall, Bridlington quay, Yorkshire.
Mar. 24, 1871.	Bentley, A. R., 36, Portland place, W.
Dec. 27, 1867.	Bentley, C. S., F.R.M.S., Hazelville villa, Sunny-side road, Hornsey rise, N.
May 22, 1868.	Berney, John, F.R.M.S., 61, North end, Croydon.
Oct. 23, 1868.	Bevington, W. A., F.R.M.S., 80, Avondale square, Old Kent road, S.E.
Mar. 28, 1879.	Bird, F. E., 42, Overton road, Brixton, S.W.
July 28, 1871.	Bishop, William, 549, Caledonian road, N.
May 27, 1881.	Bishopp, O. S., F.R.M.S., Oak villa, Muswell hill, N.
Feb. 23. 1866.	Blake, T., 6, Charlotte terrace, Brook green, Hammersmith, W.

Date of Election.	
Mar. 19, 1869.	Blankley, Frederick, F.R.M.S., Brightholm, Oakfield road, Upper Tollington park, N.
July 27, 1877.	Blenkinsop, Benjamin, 176, Queen Victoria street, E.C.
May 26, 1876.	Blundell, Joseph, 24, Davies street, Berkeley square, W.
Jan. 25, 1878.	Bogue, David, F.R.M.S., 3, St. Martin's place, Trafalgar square, W.C.
Dec. 27, 1881.	Bolton, J. G. E., M.R.C.S., Savanne, Mauritius.
Jan. 22, 1875.	Bolton, Thomas, F.R.M.S., 57, Newhall street, Birmingham.
Jan. 24, 1879.	Bond, R. C. C., 36, Keppel street, Russell square, W.C.
April 22, 1870.	Bossy, A. H., 118, Stoke Newington road, N.
May 27, 1881.	Botterill, Charles, 13, Bentley road, Liverpool.
Feb. 24, 1882.	Bound, H. J., 19, Torrington square, W.C.
Oct. 27, 1865.	Braithwaite, Robert, M.D., M.R.C.S.E., F.L.S., F.R.M.S. (*Past President*), The Ferns, 303, Clapham road, S.W.
June 28, 1878.	Brewster W., 25, Myddleton square, E.C.
May 26, 1876.	Brigstock, J. W., 4, Comberton road, Upper Clapton, E.
May 27, 1870.	Brown, G. D., M.R.C.S., Henley villa, Uxbridge road, Ealing, W.
Sept. 26, 1879.	Brown, William, B.Sc., 3, Elm cottages, Middle lane, Hornsey, N.
May 22, 1868.	Brown, W. J., 1, Lorne villas, Stodart road, Anerley.
May 26, 1871.	Browne, George, 45, Victoria road, Kentish town, N.W.
May 28, 1875.	Browne, J. W., Frascati, Masons hill, Bromley, Kent.
Feb. 27, 1872.	Browne, Rev. T. H., F.R.M.S., F.G.S., M.E.S. High Wycombe, Bucks.
Jan. 23, 1880.	Browne, W. R., 90, Morton road, Islington, N.
Jan. 26, 1877.	Buffham, T. H., 2, Connaught road, Walthamstow.
Aug. 22, 1879.	Burton, William, 27, Wigmore street, W.
Sept. 27, 1872.	Bush, William, Hanworth house, Hanworth.
May 23, 1879.	Button, Arthur, 123, Brecknock road, N.W.
June 14, 1865.	Bywater, W. M., F.R.M.S., 5, Hanover square, W.

Date of Election.	
Nov. 22, 1878.	Cafe, J. W., 46, Clifton hill, St. John's wood N.W.
June 25, 1880.	Cambridge, John, Bury St. Edmund's, Suffolk.
June 23, 1882.	Campbell, Thomas, The India Office, S.W.
Sept. 22, 1876.	Canton, Frederick, L.R.C.P., M.R.C.S., &c., 17, Great Marlborough street, Regent street, W.
May 23, 1879.	Carpenter, H.S., F.R.M.S., Beckington house, Weighton road, Anerley, S.E.
July 23, 1880.	Carr, Ebenezer, 26, Bromar road, Denmark park, S.E.
May 22, 1874.	Carruthers, Herbert.
April 25, 1879.	Cazaux, D. B., F.R.M.S., 4, Endymion terrace, Finsbury park, N.
April 25, 1879.	Chantrell, G. F., 1, St. James's mount, Liverpool.
May 26, 1882.	Chapman, W. Ingram, 2, Commercial Sale rooms, Mincing lane, E.C.
Dec. 27, 1878.	Chatto, Andrew, 214, Piccadilly, W.
Nov. 27, 1874.	Chippindale, George, Grape villa, Rothschild road, Turnham green, W.
Dec. 27, 1881.	Claremont, Claude Clarke, M.R.C.S., Millbrooke house, Hampstead, N.W.
May 22, 1874.	Clayton, James, 25, Hemingford road, Islington, N.
Oct. 25, 1878.	Clifford, Rev. H. M., M.A., Dorthgate house, 14, Avenue road, N.W.
Aug. 27, 1880.	Close, J. A., 449, Strand, W.C.
July 25, 1879.	COBBOLD, T. S., M.D., F.R.S., F.L.S. (*Past President*, *Vice-President*), 74, Portsdown road, Maida vale, W.
May 22, 1868.	Cocks, W. G., 36, Gayhurst road, Dalston, E.
Nov. 25, 1881.	Coffin, Walter H., F.L.S., F.C.S., F.R.M.S., &c., &c., 94, Cornwall Gardens, South Kensington, S.W.
Sep. 22, 1876.	Cole, A. C., F.R.M.S., St. Domingo house, Oxford gardens, Notting hill, W.
Nov. 27, 1874.	Cole, B. G., Laurel cottage, King's place, Buckhurst hill, Essex.
April 24, 1874.	Cole, William, M.E.S., *Hon. Secretary Essex Naturalists' Field Club*, Laurel cottage, King's place, Buckhurst hill, Essex.

Date of Election.	
Jan. 25, 1867.	Coles, Ferdinand, F.L.S., 18, Brooks road, Stoke Newington common, N.
Mar. 24, 1876.	Colsell, G. D., 2, Royal Exchange buildings, E.C.
Sep. 27, 1872.	Connolly, C. T., L.S.A., 3, Church hill villas, Wood green, N.
June 14, 1865.	COOKE, M. C., M.A., LL.D., A.L.S. (*President*), 146, Junction road, Upper Holloway, N.
Feb. 22, 1867.	Cooper, F. W., L.R.C.S. Edin., Leytonstone, E.
June 27, 1873.	Corbett, A. L., 103, Fentiman road, Clapham road, S.W.
May 28, 1869.	Cottam, Arthur, F.R.A.S., H.M. Office of Woods, Whitehall place, S.W.
July 26, 1872.	Cowan, T. W., F.G.S., F.R.M.S., Comptons lea, Horsham, Sussex.
Nov. 28, 1879.	Crighton, A. J., Farncombe villa, Godalming.
Aug. 28, 1868.	Crisp, Frank, LL.B., B.A., *V.P., and Treas. Linnean Society; Sec. Royal Microscopical Society*, 5, Lansdowne road, Notting hill, W.
Dec. 23, 1870.	Crisp, J. S., F.R.M.S., Ashville, Lewin road, Streatham, S.W.
July 26, 1878.	Crockford, Wm., 2, St. Peter's road, Mile end, E.
Feb. 23, 1877.	Crofton, Edward, M.A. Oxon., F.R.M.S., 45, West Cromwell road, South Kensington, S.W.
June 24, 1881.	Crosby, H. T., 21, Gordon square, W.C.
Sept. 28, 1866.	Crouch, Henry, F.R.M.S., 66, Barbican, E.C.
June 22, 1877.	Cunliffe, P. G., F.R.M.S., The Elms, Handforth, Manchester.
Nov. 26, 1875.	Cunningham F. B., 8, Durham terrace, Westbourne park, W.
June 25, 1880.	Curties, C. L., 244, High Holborn, W.C.
May 25, 1866.	Curties, Thomas, F.R.M.S., 244, High Holborn, W.C.
June 25, 1880.	Curties, W. I., 244, High Holborn, W.C.
Sept. 26, 1879.	Curtis, Charles, 29, Baker street, Portman sq., W.
Aug. 22, 1879.	Cuttell, F. G. 52, New Compton street, Soho, W.
April 22, 1881.	Cutting, W. M., 1, Curtain road, E.C.
Jan. 22, 1875.	Dadswell, Edward, 42, Barrington road, Stockwell, S.W.

Date of Election.

Mar. 24, 1882. Dale, Bernard, 14, Elm grove, Lee, Kent.

Nov. 23, 1877. Dallas, W. S., F.L,S., &c., the Geological Society, Burlington house, Piccadilly, W.

May 23, 1879. Dallmeyer, T. R., 19, Bloomsbury street, W.C.

Mar. 22, 1878. Darby, the Ven. Archdeacon, St. Bridget's rectory, Chester.

Mar. 22, 1878. Darke, Edward, 2, Brecknock crescent, Camden road, N.W.

May 23, 1874. Davey, R. F., War Office, Pall Mall, S.W.

Oct. 22, 1869. Davis, Henry, 19, Warwick street, Leamington.

May 23, 1879. Dawson, William, 24, Abbeygate street, Bury St. Edmunds, Suffolk.

May 28, 1875. Dean, Arthur (*Hon. Sec. East Lond. Mic. Soc.*), 12, Vernon road, Tredegar road, Bow, E.

Feb. 23, 1877. Death, James, jun., 38, Gladstone street, St. George's road, Southwark, S.E.

Feb. 28, 1879. Debenham, E. H., 9, Mincing lane, E.C.

Jan. 24, 1879. Deby, Julien, C.E., F.R.M.S., 75, Holland road, Kensington, W.

Feb. 23, 1877. Delferier, W. A., F.R.M.S., 15, Penywern road, South Kensington, S.W.

Nov. 24, 1876. Despointes, Francis, 16, St. George's square, Regent's park road, N.W.

Nov. 25, 1881. Dixon, George S., 4, Brooklyn road, Shepherd's bush road, W.

May 23, 1879. Dixon, W. F., 18, University street, W.C.

Nov. 24, 1865. Dobson, H. H., F.R.M.S., Holmesdale, Grange park, Ealing, W.

Nov. 27, 1868. Douglas, Rev. R. C., Manaton rectory, Moretonhampstead, Exeter.

Oct. 25, 1878. Dowler, Captain F. E., Naval and Military Club, Piccadilly, W.

Jan. 23, 1880. Dowsett, G. H., 38, Egerton road, Blackheath road, S.E.

Nov. 22, 1878. Drayton, H. F. E., Horton house, Beckenham, Kent.

July 28, 1871. Drew, G. C., Milton house school, Clapton common, S.E.

July 25, 1879. Driver, Alfred, 23, Leighan court road, West Streatham, S.W.

Date of Election.	
Aug. 26, 1872.	Dudgeon, R. E., M.D., 53, Montagu square, W.
Oct. 25, 1872.	Dunning, C. G., 55, Camden park road, N.W.
Sept. 22, 1865.	Durham, A. E., F.R.C.S., F.L.S., F.R.M.S., &c. (*Past President*), 82, Brook street, Grosvenor square, W.
Jan. 24, 1879.	Easty, C. W., 19, Edith road, St. Mary's road, Peckham, S.E.
Sept. 25, 1868.	Eddy, J. R., F.R.M.S., F.G.S., The Grange, Carleton, Skipton, Yorkshire.
June 28, 1867.	Edmonds. R., 178, Burrage road, Plumstead, S.E.
May 26, 1876.	Emery, Charles (*Hon. Curator*), 6, Laburnum cottages, Middle lane, Crouch end, N.
May 26, 1871.	Enock, Frederick, Ferndale, Bath Road, Woking Station.
Feb. 28, 1879.	Epps, Hahnemann, 9, Eliot bank, Sydenham hill, S.E.
Dec. 27, 1878.	Erlebach, H. A., Mill hill school, Mill hill, N.W.
Feb. 25, 1881.	Essell, G. F. S., Christ Church vicarage, Spa road, Bermondsey, S.E.
Dec. 17, 1875.	Farries, Thomas, F.C.S.
July 25, 1873.	Fase, Rev. H. J., 5, Bessborough gardens, S.W.
June 25, 1875.	Faulkner, Henry, jun., Fernwood, Roehampton park, S.W.
Jan. 28, 1876.	Faulkner, John.
Feb. 27, 1880.	Fieldwick, Alfred, jun., 284, Dalston lane, Hackney, E.
July 22, 1881.	Firth, W. A., Whiterock, Belfast.
Feb. 24, 1882.	Fitch, J. Nugent.
July 26, 1867.	Fitch, Frederick, F.R.G.S., F.R.M.S., Hadleigh house, Highbury New park, N.
Nov. 28, 1879.	Forster, William, jun., Cleveland road, Woodford, Essex.
Mar. 24, 1871.	Foulerton, John, M.D., Science club, 4, Savile row, W.
July 26, 1878.	Fowke, Francis, F.R.M.S., 40, Nottingham place, W.
Dec. 28, 1866.	Fox, C. J., F.R.M.S., 26, South Molton street, Oxford street, W.

Date of Election.	
Nov. 26, 1875.	Freckelton, Rev. T. W., F.R.M.S., 28A, Lonsdale square, Islington, N.
Jan. 23, 1880.	Freeland, F. J., M.R.C.S., J.P., North street, Chichester.
June 23, 1871.	Freeman, H. E., 1, Templeton road, Finsbury park, N.
May 22, 1868.	Fryer, G. H., 107, Belsize road, N.W.
July 23, 1880.	Funston, James, 93, Finsbury pavement, E.C.
May 25, 1866.	Gardiner, George, F.M.S., 23, St. Paul's road, N.W.
June 23, 1882.	Garden, Alexander, M.D., Brigade Surgeon, 16, Aynhoe road, West Kensington park.
Mar. 25, 1870.	Garden, R. S., 42, Carlton hill, St. John's wood, N.W.
Feb. 26, 1875.	Gardner, Edmund, 454, Strand, W.C.
July 27, 1877.	Gardner, J. H., A.K.C., 44, Berners street, W.
April 24, 1868.	Garnham, John, F.R.M.S., Hazelwood, Crescent road, St. John's, Upper Lewisham, S.E.
April 23, 1880.	Gates, G. W. H., 21, Lombard street, E.C.
July 7, 1865.	Gay, F. W., F.R.M.S. (*Hon. Treasurer*), 113, High Holborn, W.C.
June 25, 1880.	George, C. F., M.R.C.S., Kirton-in-Lindsey, Lincolnshire.
July 26, 1867.	George, Edward, F.R.M.S., 12, Derby villas, Forest hill, S.E.
April 26, 1878.	Gibbins, G. W.
July 22, 1870.	Gibson, J. F., F.R.M.S., Clovelly, Lancaster road, Lower Norwood, S.E.
June 14, 1865.	Gibson, W., 3, Bridge street, Westminster, S.W.
April 27, 1877.	Gilbertson, Henry, Mangrove house, Hertford.
June 24, 1881.	Gilburt, Henry, 63, Rectory road, Stoke Newington, N.
Oct. 27, 1876.	Gilburt, W. H., F.R.M.S., 48, Wetherell road, South Hackney, E.
Feb, 25, 1881.	Glaisher, James, F.R.S., F.R.A.S., F.R.M.S., &c., 1, Dartmouth place, Blackheath, S.E.
June 27, 1873.	Glasspoole, H. G., 15, Mall road, Hammersmith, W.
Feb. 25, 1876.	Godwin, John, 219, Brompton road, S.W.
Nov. 28, 1879.	Goodinge, A. C., 119, High Holborn, W.C.

Date of Election.

April 26, 1872.	Goodinge, J. W., F.R.G.S., F.R.M.S., 119, High Holborn, W.C.
Nov. 23, 1877.	Goodwin, William, 162, Elthorne road, Hornsey rise, N.
Mar. 27, 1866.	Gray, S. O., Bank of England, E.C.
Nov. 27, 1874.	Grayling, J. F., Sittingbourne, Kent.
May 22, 1874.	Green, G., 6, Helmet row, St. Luke's, E.C.
April 22, 1881.	Green, J. R.
Aug. 22, 1879.	Greenhough, D. W., F.R.M.S., South bank, Breakspeare road, Lewisham high road, S.E.
Feb. 24, 1882.	Greening, Linnæus, Birch house, Warrington.
Oct. 23, 1868.	Greenish, Thomas, F.R.M.S., 20, New street, Dorset square, N.W.
Oct. 23, 1868.	Gregory, H. R., 1, Wellington square, King's road, Chelsea, S.W.
May 22, 1874.	Grey, Ernest, 290, Essex road, Islington, N.
July 24, 1868.	Groves, J. W, F.R.M.S., 90, Holland road, Kensington, W., and Physiological Laboratory, King's College, W.C.
May 28, 1880.	Groves, William, 28, Manor park, Lee, S.E.
July 24, 1868.	Grubbe, E. W., C.E., 73, Redcliffe gardens, S.W.
Jan. 27, 1871.	Guimaraens, A. de Souza, F.R.M.S., 50, Lowden road, Herne hill, S.E.
Jan. 23, 1874.	Hadland, J. H., 11, King William street, E.C.
Sept. 28, 1877.	Hagger, John, Repton school, Burton-on-Trent.
Feb. 25, 1881.	Haigh, William, Tempsford villa, Uxbridge road, Ealing, W.
June 14, 1865.	Hailes, H. F. (*Hon. Secretary for Foreign Correspondence*), 5, Richmond villas, Middle lane, Crouch end, N.
Aug. 26, 1870.	Hailstone, R. H., 91, Adelaide road, N.W.
Feb. 23, 1867.	Hainworth, William, 3, Pembury road, Clapton, E.
July 28, 1876.	Halford, Edward, 18, Leinster square, Bayswater, W.
Dec. 28, 1866.	Hallett, R. J., 123, Seymour street, Euston square, N.W.
Feb. 22, 1869.	Hammond, A. F.L.S., 13, Rock's mount road, Central hill, Norwood, S.E.

Date of Election.	
June 25, 1880.	Hancock, H. S. H., 93, Aden grove, Stoke Newington, N.
Jan. 24, 1879.	Harding, Burcham, 128, Adelaide road, N.W.
Feb. 24, 1882.	Harding, J. H., 4, Finsbury square, E.C.
July 23, 1880.	Hardingham, A. S., 3, Serjeant's inn, Chancery lane, E.C.
July 25, 1879.	Hardingham, G. G., F.R.M.S., 33, St. George's square, S.W.
Jan. 23, 1874.	Hardy, J. D., 73, Clarence road, Clapton, E.
Sept. 28, 1866.	Harkness, W., F.R.M.S., Laboratory, Somerset house, W.C.
June 23, 1871.	Harris, Edward, F.R.M.S., Rydal villa, Longton grove, Upper Sydenham, S.E.
Jan. 25, 1878.	Harrison, D. H., Argyll villas, Mattock lane, Ealing, W.
June 24, 1881.	Harrison, F. W., 69, Sewardstone road, Victoria park, E.
April 23, 1875.	Harrison, James, 150, Akerman road, North Brixton, S.W.
July 26, 1872.	Harrod, John, Mark lane square, E.C.
Mar. 28, 1879.	Hawkins, C. E., H.M. Geological Survey, Jermyn street, S.W.
June 24, 1870.	Hawkins, S. J.
June 28, 1867.	Hawksley, T. P., 97, Adelaide road, N.W.
Sept. 28, 1877.	Headley, Robert., F.R.G.S., 44, Walham grove, Walham green, S.W.
Aug. 23, 1872.	Hembry, F. W., F.R.M.S., *Hon. Sec., S. Lond. Mic. and Nat. Hist. Soc.*, 150, Stockwell park road, Brixton, S.W.
June 26, 1868.	Henry, A. H., 73, Redcliffe gardens, S.W.
Sept. 23, 1881.	Hensoldt, Heinrich, 7, Machell road, Nunhead, S.E.
May 22, 1868.	Hicks, J. J., 8, Hatton garden, E.C.
June 22, 1877.	Hill, R. W., 41, Lothbury, E.C.
Sept. 24, 1869.	Hilton, T. D., M.D., Upper Deal, Deal, Kent.
Sept. 28, 1866.	Hind, F. H. P., Bartholomew house, Bartholomew lane, E.C.
May 22, 1874.	Hind, George, 244, High Holborn, W.C.
July 26, 1872.	Hinton, Ernest.
Aug. 26, 1870.	Hirst, John, F.R.M.S., Ladcastle, Dobcross, Manchester.

Date of Election.	
Sept. 26, 1879.	Hobden, Horace, St. Bartholomew's hospital, E.C.
Feb. 26, 1875.	Holford, Christopher, Bounty office, Dean's yard, Westminster, S.W.
Jan. 23, 1880.	Holland, C. F., 14, Wayland avenue, Sandringham road, Hackney, E.
April 26, 1867.	Hooton, Charles, Sunningdale house, Bickerton road, Upper Holloway, N.
Nov. 26, 1880.	Hopkins, Robert, 45, Denmark street, Camberwell, S.E.
April 28, 1876.	Horn, W. E., A.I.C.E., 10, Vincent square, Westminster, S.W.
Oct. 26, 1866.	Horncastle, Henry, Whitemoor house, Ollerton, Newark.
June 25, 1869.	Houghton, W., Hoe street, Walthamstow, E.
May 22, 1874.	Hovenden, C. W., F.R.M,S., 95, City road, E.C.
April 26, 1867.	Hovenden, Frederick, F.R.M.S., Glenlea, Thurlow park road, Dulwich, S.E.
June 23, 1876.	How, W. S., 75, Great Portland street, W.
Oct. 27, 1876.	Howard, D., 60, Belsize park, N.W.
Oct. 25, 1878.	Howling, W. E., Crowley's Brewery, Alton, Hants.
Feb. 25, 1870.	Hudleston, W. H , J.P., F.G.S., 23, Cheyne walk, S.W.
Feb. 28, 1879.	Hudson, C. T., M.A., LL.D. Cantab., F.R.M.S, 6, Royal York Crescent, Clifton, Bristol.
Jan. 26, 1872.	Hudson, Robert, F.R.S., F.L.S., F.R.M.S., &c., Clapham common, S.W.
Nov. 28, 1879.	Hughes, R. J., L.R.C.P., L.R.C.S., L.M., 15, Queen's road, Finsbury park, N.
Jan. 23, 1880.	Hunt, Frederick, York lodge, Stamford hill, N.
Dec. 28, 1866.	Hunt, W. H. B., F.R.M.S., 160, Camden road, N.W.
Dec. 22, 1876.	Hunter, J. J., 20, Cranbourne street, W.C.
July 25, 1873.	Hurst, J. T., Royal Engineer Office, Portsmouth.
June 28, 1878.	Huxley, Prof. T. H., F.R.S., &c., (*Past President*), Science Schools, South Kensington, S.W.
May 24, 1867.	Ingpen, J. E., F.R.M.S (*Hon. Secretary*), 7, The hill, Putney, S.W.
Aug. 22, 1873.	Israel, S., 18, Stepney green, Mile end road, E.

Date of Election.

Dec. 17, 1869. Jackson, B. D. (*Sec. Linnean Society*), F.R.M.S., 30, Stockwell road, S.W.

Dec. 17, 1875. Jackson, C. L., F.L.S., F.Z.S., F.R.M.S., Hill Fold, Sharples, Bolton.

July 24, 1868. Jackson, F. R., Culver cottage, Slindon, Arundel, Sussex.

June 25, 1880. Jacques, Walter, 2, Fenchurch buildings, E.C.

June 14, 1865. Jaques, Edward, B.A., F.R.M.S., H.M. Office of Woods, Whitehall place, S.W.

Feb. 28, 1873. Jenkins, J. W., 3, Harcourt road, Wallington.

July 24, 1868. Jennings, Rev. Nathaniel, M.A., F.R.A.S., 1, Grove terrace, Highgate road, N.W.

Jan. 25, 1867. Johnson, J. A., 15, Wellington road, Stoke Newington, N.

Feb. 24, 1871. Johnson, M. Hawkins, F.R.M.S., F.G.S., 379, Euston road, N.W.

June 23, 1876. Johnson, T. R.

Feb. 23, 1877. Johnston, J. M. C.

Mar. 24, 1871. Johnstone, James, Stanhope lodge, Bideford.

Oct. 25, 1872. Jones. E. W., F.R.A.S., F.R.M.S., 53, Cowley road, North Brixton, S.W.

Feb. 28, 1873. Jones, G. J., 7, Mount Preston, Leeds.

June 25, 1875. Jones, J. B., F.R.M.S., St. George's Chambers, 10, St. George's crescent, Liverpool.

Nov. 25, 1870. Jones, Lieut.-Col. Lewis, St. Bernard's, Maple road, Surbiton.

May 23, 1873. Jones, Captain L. F., United Service Club, Pall Mall, S.W.

June 23, 1876. Jones, T. E., 46, Park street, Stoke Newington, N.

Jan. 27, 1882. Jones, Rev. T. R., M.A., Codicote Vicarage, Welwyn, Herts.

May 23, 1873. Karop, G. C., M.R.C.S., &c., 198, Holland road, Kensington, W.

Aug. 23, 1867. Kiddle, Edward, The War Office, Pall Mall, S.W.

Mar. 19, 1869. Kilsby, T. W., 4, Brompton villas, Edmonton.

April 22, 1881. King, H. W., The Cedars, Upper Park road, New Southgate, N.

Dec. 23, 1870. King, Robert, F.R.M.S., Fern house, Upper Clapton, E.

Date of Election.	
May 24, 1878.	King, W. T., M.D., M.R.C.S., 74, Victoria park road, South Hackney, E.
Nov. 26, 1880.	Kingsett, C. T., F.C.S., F.I.C.
Feb. 28, 1873.	Kitsell, F. J., 41, Latymer road, W.
Mar. 23, 1877.	Kluht, H. J., 42, Westbourne grove, Bayswater, W.
Oct. 24, 1873.	Knight, J. M., 50, Bow road, E.
Nov. 25, 1870.	Ladd, William, F.R.A.S., F.R.M.S., Claremont villa, Rectory road, Beckenham, Kent.
Jan. 24, 1879.	Lancaster, A. H., 7, Campden hill gardens, Kensington, W.
Mar. 22, 1867.	Lancaster, Thomas, Bownham house, Stroud, Gloucestershire.
May 25, 1877.	Lane-Fox, Hon. Sackville F. H.
Jan. 28, 1881.	Lankester, H. H., 4, Claverton street, S.W., and Medical School, St. Thomas' hospital.
May 28, 1875.	Larkin, John, 24, Charterhouse square, E.C.
Nov. 26, 1880.	Larking, R. J., 98, Clarence road, Lower Clapton, E.
June 25, 1869.	Layton, C. E., 12, Upper Hornsey rise, N.
Aug. 28, 1868.	Leaf, C. J., F.L.S., F.R.M.S., &c. (*President of the Old Change Microscopical Society*), Old Change, E.C.
Mar. 19, 1869.	Lee, Henry, F.L.S., F.R.M.S., &c. (*Past President*), Ethelbert house, Margate.
June 23, 1876.	Leeson, H. S., 4, Old buildings, Lincoln's Inn, W.C.
Feb. 25, 1881.	Leicester, Alfred, 13, Adelaide terrace, Waterloo, Liverpool.
Oct. 25, 1867.	Leifchild, J. R., M.A., 6, St. Lawrence road, Nottinghill, W.
Sept. 22, 1865.	Leighton, W. H., 2, Merton place, Chiswick, W.
July 25, 1873.	Le Pelley, Charles, 84, St. Thomas' road, Seven Sister's road, N.
April 27, 1866.	Lewis, R. T., F.R.M.S. (*Hon. Reporter*), 1, Masbro' road, Brook green, W.
June 26, 1868.	Lindley, W. H., jun., 29, Blittersdorffs platz, Frankfort-on-Maine.
May 26, 1871.	Locke, John, 16, Georgiana street, Camden town, N.W.

Date of Election.	
April 23, 1869.	Long, Henry, 90, High street, Croydon.
Nov. 24, 1866.	Lovibond, J. W., F.R.M.S., St. Anne street, Salisbury.
Sept. 22, 1866.	Lovick, T., 53, Queen's crescent, Haverstock hill, N.W.
Dec. 18, 1868.	Lowne, B. T., F.R.C.S., F.L.S., F.Z.S., 65, Cambridge gardens, Bayswater, W.
April 27, 1866.	Loy, W. T., F.R.M.S., Five Oaks, Billingshurst, Sussex.
Nov. 23, 1866.	McIntire, S. J., F.R.M.S., 14, Hettley road, Uxbridge road, Shepherd's bush, W.
Jan. 28, 1881.	McKenzie, J. A., The Warren, Loughton, Essex.
Jan. 26, 1872.	Mackechnie, J. H., M.D., 60, Wimpole street, Cavendish square, W.
Jan. 23, 1880.	Mackenzie, James, Warden villa, Uxbridge road, Ealing, W.
June 28, 1878.	Magor, J. B., L.D.S., 24, Chapel street, Penzance.
July 26, 1874.	Magor, Thomas, M.D., Eagle cottage, Hornsey, N.
Sept. 27, 1872.	Manning, H. E. the Cardinal Archbishop, Archbishop's house, Westminster, S.W.
Jan. 23, 1880.	Martin, Francis, R.N., Shrub cottage, Fairfield road, Old Charlton, Kent.
Sept. 22, 1876.	Martin, W. H., 11, Markham square, Chelsea, S.W.
Dec. 27, 1867.	Martinelli, A., 57, Prince of Wales crescent, Haverstock hill, N.W.
April 26, 1867.	Matthews, G. K., St. John's lodge, Beckenham, Kent.
Oct. 26, 1866.	Matthews, John, M.D., F.R.M.S. (*Past President*), 30, Colebrooke row, Islington, N.
May 26, 1871.	May, J. W., F.R.M.S., Arundel house, Percy cross, Fulham, S.W.
Feb. 27, 1874.	May L. J., 371, Holloway road, N.
Dec. 17, 1875.	May, Thomas.
Feb. 25, 1876.	May, W. R.
Mar. 22, 1867.	Meacher, J. W., 10, Hillmarten road, Camden road, N.

Date of Election.	
Feb. 28, 1879.	Menzies, James, 13, Leighton grove, N.W.
May 22, 1874.	Messenger, G. A., 31, Glengall road, Old Kent road, S.E.
Dec. 18, 1868.	Mestayer, Richard, F.L.S., F.R.M.S., 7, Buckland crescent, Belsize park, N.W.
July 27, 1877.	Michael, A. D., F.L.S., F.R.M.S., 3 and 4, Great Winchester street, E.C.
May 28, 1880.	Miles, Andrew, 185, Camden grove, Peckham, S.E.
Feb. 25, 1881.	Millar, John, L.R.C.P., F.L.S., F.R.M.S., Bethnal house, Cambridge road, E.
July 7, 1865.	Millett, F. W., F.R.M.S., 13, Milner square, Islington, N.
Oct. 22, 1880.	Milner, W. E., 47, Park road, Haverstock hill, N.W.
Jan. 23, 1874.	Moreland, Richard, jun., M.I.C.E., F.R.M.S., 4, The Quadrant, Highbury, N.
July 26, 1878.	Morland, Henry, Cranford, near Hounslow.
Oct. 27, 1866.	Morrieson, Colonel R., F.R.M.S., Oriental Club, Hanover square, W.
Dec. 27, 1876.	Morris, J. G., M.R.C.S., 135, St. Owen street, Hereford.
Oct. 27, 1876.	Morris, W. G., L.D.S., The Lodge, Sansome walk, Worcester.
Nov. 23, 1877.	Morten, T. S., 42, Haverstock hill, N.W.
Jan. 24, 1879.	Murray, James, Osborne house, 50, Percy road, Shepherd's bush, W.
Jan. 25, 1867.	Murray, R. C., 69, Jermyn street, St. James's, S.W.
Mar. 23, 1866.	Nation, W. J., 30, King square, Goswell road, E.C.
Feb. 22, 1878.	Needham, S. H., F.R.G.S., F.G.S., 33, Somerfield road, Finsbury park, N.
Mar. 24, 1876.	Nelson, E. M., 9, Marlborough hill, N.W.
Mar. 24, 1871.	Nelson, James, 3, Oakden street, Kennington road, S.E.
Feb. 28, 1879.	Nesbitt, Henry, F.R.G.S., F.R.M.S., 12, Victoria villas, Kilburn, N.W.
Nov. 25, 1881.	Nevins, R. T. G., 80, Tufnell park road, N.

Date of Election.	
May 23, 1879.	Newcombe, Prout, Northcote, East Croydon.
Nov. 23, 1877.	Newth, A. H., M.D., Science Club, 4, Savile row, W.
Jan. 26, 1872.	Newton, E. T., F.G.S., Geological Museum, Jermyn street, S.W.
Feb. 27, 1880.	Niven, George, 41, Albert road, Finsbury park, N.
May 22, 1874.	Nixon, P. C., Oporto, Portugal.
Mar. 25, 1881.	Norman, Edwin, 178, City road, E.C.
Aug. 26, 1881.	Northey, M. D., 4, Lower Brighton terrace, Surbiton.
Jan. 24, 1879.	Offord, J. M., 31, Hereford square, S.W.
Dec. 22, 1876.	Ogilvy, C. P., F.L.S., Sizewell house, Leiston, near Saxmundham, Suffolk.
May 24, 1878.	O'Hara, Lt.-Col. Richard, F.R.M.S. (late Royal Artillery), West lodge, Galway.
June 23, 1882.	Ollard, John Alex., F.R.M.S., Ye Hermitage, Forty hill, Enfield.
July 28, 1882.	Ondaatje, Dr. W. C., 67, Torrington square, W.C.
June 22, 1877.	Oswin, Frederick, F.S.A., 10, Gower street, W.C.
Dec. 27, 1867.	Oxley, Frederick, F.R.M.S., 8, Crosby square, Bishopsgate street, E.C.
July 25, 1879.	Palmer, G. H., 95, Cornwall gardens, S.W.
May 22, 1874.	Palmer, Thomas, B.Sc., F.R.M.S., Holme Lee, Lower Camden, Chislehurst, Kent.
Oct. 27, 1871.	Parsons, F. A., 90, Leadenhall street, E.C.
Dec. 28, 1877.	Partridge, Thos., M.D., Stroud, Gloucestershire.
April 23, 1875.	Peal, C. N., F.R.M.S., Fernhurst, Mattock lane, Ealing, W.
May 24, 1867.	Pearce, George, Villa Helvetia, Tufnell park, N.
April 27, 1877.	Pearcy, A. C., 20, Castlewood road, Craven park, Stamford hill, N.
May 24, 1867.	Pearson, John, 212, Edgware road, W.
July 22, 1881.	Perigal, Henry, F.R.A.S., F.R.M.S., 9, North crescent, Bedford square, W.C.
Oct. 27, 1865.	Pickard, J. F., 195, Great Portland street, W.
May 23, 1879.	Pilcher, W. J., F.R.C.S., &c., Boston, Lincolnshire.

Date of Election.	
June 24, 1881.	Pilley, J. J., 8, Ellesmere road north, Bow, E.
Jan. 22, 1869.	Pillischer, Moritz., F.R.M.S., 88, New Bond street, W.
Nov. 24, 1871.	Pitts, Frederick, Harvard house, St. John's hill, Clapham, S.W.
Sept. 27, 1878.	Plomer, G. D., F.R.M.S., 48, Springfield road, St. John's wood, N.W.
Sept. 28, 1877.	Pocklington, Henry, F.R.M.S., 20, Park road, Leeds.
Nov. 23, 1866.	Potter, George, F.R.M.S., 42, Grove road, Holloway, N.
Jan. 25, 1878.	Potts, R. A., 26, South Audley street, W.
June 24, 1881.	Potts, William, Hillside avenue, Beckenham, Kent.
June 22, 1866.	Powe, I., 71, George street, Richmond, Surrey.
May 25, 1866.	Powell, Hugh, F.R.M.S., 170, Euston road, N.W.
April 25, 1879.	Powell, H. P., The Butts, Brentford.
May 26, 1876.	Powell, J. T., 32, Dunlace road, Lower Clapton, E.
July 7, 1865.	Powell, Thomas, F.R.M.S., 18, Doughty street, Mecklenburg square, W.C.
Jan. 22, 1875.	Power, H. D'Arcy, F.L.S.
April 25, 1879.	Preedy, W. H., 41, Oseney crescent, Camden road, N.W.
June 27, 1873.	Priest, B. W., 22, Parliament street, S.W.
May 23, 1879.	Pritchard, J. D., Crymlyn Burrows, near Swansea.
July 26, 1867.	Pritchett, Francis, 137, Fenchurch street, E.C.
Feb. 25, 1881.	Probyn, Clifford, 55, Grosvenor street, W.
April 23, 1868.	Quekett, A. J. S., 51, Warwick road, Maida hill, W.
April 23, 1868.	Quekett, A. E., 51, Warwick road, Maida hill, W.
April 23, 1868.	Quekett, Rev. Wm., The Rectory, Warrington.
Feb. 23, 1866.	Quick, G. E., 74, Long lane, Bermondsey, S.E.
Oct. 26, 1866.	Rabbits, W. T., Highfield, Dartmouth park, Forest hill, S.E.

Date of Election.	
Sept. 24, 1869.	Radcliffe, J. D.
Oct. 22, 1880.	Radcliffe, William, 43, Queen's road, Brownswood park, N.
June 25, 1875.	Radford, W. S., M.D., F.R.M.S., Sidmouth.
Oct. 26, 1866.	RAMSDEN, HILDEBRAND, M.A. Cant., F.L.S., F.R.M.S. (*Vice-President*), 26, Upper Bedford place, Russell square, W.C.
Aug. 28, 1868.	Rance, T. G., Elmside, Bickley, Kent.
June 24, 1881.	Ransom, F., Fairfield, Hitchin.
May 22, 1868.	Rawles, W., 64, Kentish town road, N.W.
July 23, 1880.	Read, Rev. William., M.A., F.R.A.S., F.R.M.S., &c., Worthing, Sussex.
Dec. 27, 1878.	Reed, J. M., Sidmouth house, South park, Ilford, E.
June 22, 1877.	Reed, J. W., F.R.G.S., F.R.M.S., 17, Colebrook row, Islington, N.
June 27, 1873.	Reeve, Frederick., 113, Clapham road, S.W.
July 7, 1865.	Reeves, W. W., F.R.M.S., 30, Ashburnham grove, Greenwich, S.E.
May 22, 1874.	Reid, W. W., Corra Lynn, Selhurst park, South Norwood, S.E.
Oct. 28, 1881.	Reynolds, W. P., 74, King William street, E.C.
Mar. 25, 1870.	Richardson, T. H.
May 23, 1879.	Rideout, William, F.R.M.S. (*Hon. Sec. Bolton Microscopical Club*), Hulliwell, Bolton.
June 25, 1869.	Roberts, J. H., F.R.C S.
April 26, 1872.	Roberts, S. H., F.R.M.S.
May 22, 1868.	Rogers, John, F.R.M.S., 4, Tennyson street, Nottingham.
Oct. 26, 1866.	Rogers, Thomas, F.L.S., F.R.M.S., Selmeston house, Thurlow park road, West Dulwich.
Mar. 22, 1872.	Rolfe, C. S., 5, Westminster chambers, S.W.
May 22, 1868.	Roper, Freeman C. S., F.L.S., F.G.S., F.R.M.S., Palgrave house, Eastbourne, Sussex.
June 23, 1876.	Roper, H. J., F.R.M.S., 5, Lausanne road, Peckham, S.E.
Oct. 27, 1876.	Roper, Robert, 29, Hampton road, Upton, Essex.
July 24, 1868.	Rowe, James, jun., M.R.C.V.S., 65, High street, Marylebone, W.
May 23, 1879.	Rowe, T. S., M.D., Cecil square, Margate.

Date of Election.

Oct. 26, 1866. Rowlett, John, 92, Inville road, Walworth, S.E.

Aug. 26, 1881. Roy, Eugene L., B.A., 1, Lady Margaret's road, Kentish town, N.W.

Sept. 24, 1880. Rudkin, F. D., 80, Moray road, Tollington park, N.

July 24, 1874. Rushton, William, 61, Tufnell park road, Holloway, N.

Oct. 27, 1865. Russell, James, 10, High street, Shoreditch, E.

May 22, 1868. Russell, T. D., Coningsby villas, Rosendale road, West Dulwich, S.E.

Feb. 22, 1867. Rutter, H. L., 24, Crownhurst road, Angel road, Brixton, S.W.

Feb. 27, 1880. Ryley, Thomas, Lee Park house, Blackheath, S.E.

Nov. 22, 1878. Sabel, E. E., 6, Grove road, Clapham park, S.W.

May 23, 1873. Salkeld, Lt.-Col. J. C., F.R.M.S., 29, St. James's street, S.W.

Dec. 27, 1878. Salmon, C. W., 7, Manor park villas, Manor road, Stoke Newington, N.

Dec. 17, 1869. Salmon, John, 24, Seymour street, Euston square, N.W.

Dec. 28, 1877. Sands, Charles, 5, Woburn place, Russell square, W.C.

May 28, 1875. Saul, G. W.

June 27, 1879. Sawyer, G. D., F.R.M.S., 55, Buckingham place, Brighton.

Feb. 27, 1880. Schulze, Adolf, 1, St. James's street, Hillhead, Glasgow, N.B.

Feb. 26, 1875. Scofield, W. J., M.R.C.S., F.L.S., 13, South Hill park gardens, Hampstead, N.W.

Mar. 24, 1882. Selby, Henry, 71, Alderney street, Pimlico, S.W.

May 24, 1872. Sequeira, H. L., M.R.C.S., 1, Jewry street, Aldgate, E.C.

July 27, 1868. Sewell, Richard, Ashmore house, Keston, Kent.

July 23, 1880. Shaw, H. V., Fir Croft, Keymer, Hurstpierpoint, Sussex.

Oct. 22, 1869. Shaw, W. F., Mosshall grove, Finchley, N.

May 26, 1876. Shepheard, Thomas, F.R.M.S., Kingsley lodge, Chester.

Date of Election.	
May 26, 1871.	Sigsworth, J. C., F.R.M.S., 18, Chaucer road, Herne hill, S.E.
June 27, 1873.	Simmonds, J. E., Royal Exotic Nursery, King's road, Chelsea, S.W.
Aug. 23, 1867.	Simmons, J. J., L.D.S., 18, Burton crescent, Euston road, N.W.
Oct. 28, 1881.	Simons, W. V., 19, Manley terrace, Kennington park, S.E.
May 26, 1876.	Simpson, Edward, 24, Grummant road, Peckham road, S.E.
Nov. 23, 1877.	Simpson, Thomas, Fennymere, Castlebar, Ealing, W.
Mar. 27, 1868.	Simson, Thomas.
May 28, 1869.	Sketchley, H. G., care of S. A. Sketchley, Esq., War Office, Pall Mall, S.W.
Dec. 28, 1866.	Slade, J., Fern villa, Lion road, Bexley heath, Kent.
Oct. 23, 1868.	Smart, William, 27, Aldgate, E.
May 25, 1866.	Smith, Alpheus (*Hon. Librarian*), 39, Choumert road, Rye lane, Peckham, S.E.
April 23, 1880.	Smith, A. S., Silvermere, Cobham, Surrey.
Oct. 26, 1877.	Smith, B. E., Normal School of Science, South Kensington Museum, S.W.
July 25, 1879.	Smith, C. V., 5, Parade, Carmarthen.
Feb. 25, 1876.	Smith, Edward, F.S.S., St. Mildred's house, Poultry, E C.
Mar. 25, 1870.	Smith, F. L., 3, Grecian cottages, Crown hill, Norwood, S.E.
June 27, 1873.	Smith, G. J., F.R.M.S., 73, Farringdon street, E.C.
June 26, 1868.	Smith, James, F.L.S., F.R.M.S., 1, Canonbury terrace, Islington, N.
Dec. 23, 1870.	Smith, J. A.
Oct. 26, 1877.	Smith, Samuel, 331, Hackney road, E.
Mar. 24, 1882.	Smith, W. Dalton, 2, Craigs court, Charing Cross, S.W.
Aug. 23, 1872.	Smith, W. S., 30, Loraine road, Holloway, N.
May 26, 1882.	Snell, H. Saxon, junr., 86, Belsize road, St. John's Wood, N.W.
April 24, 1868.	Snellgrove, W., 58, Cranfield road, Wickham park, S.E.

Date of Election.

Aug. 22, 1879. Soames, Rev. H. A., B.A.
Sept. 22, 1865. Southwell, C., 44, Princes street, Soho, W.
May 26, 1876. Southwell, C. W., 35, Douglas road, Cannonbury, N.
May 22, 1874. Spencer, James, F.R.M.S., 50, South street, Greenwich, S.E.
June 26, 1876. Spencer, John, Brook's Bank, 81, Lombard street, E.C.
Nov. 22, 1872. Spencer, Thomas, F.C.S., F.R.M.S., 32, Euston square, N.W.
Mar. 24, 1866. Starling, Benjamin, 9, Gray's inn square, W.C.
Aug. 23, 1878. Steel, J. H., M.R.C.V.S., F.Z.S., The Royal Veterinary college, Camden town, N.W.
Feb. 23, 1872. Stevens, C. R., 7, Ashby road, Canonbury, N.
Aug. 24, 1866. Steward, J. H., F.R.M.S., 406, Strand, W.C.
June 22, 1877. STEWART, CHARLES, M.R.C.S., F.L.S., *Sec. R.M.S.*, &c. (*Vice-President*), St. Thomas' hospital and 42, Sinclair road, Kensington, W.
April 23, 1880. Stewart, Frederick.
Sept. 22, 1876. Stiles, M. H.
May 23, 1879. Stocken, James, 21, Endsleigh gardens, N.W.
Jan. 23, 1880. Stœssiger, F. A., 70, Windsor road, Holloway, N.
June 24, 1881. Stokes, A. W., F.C.S., Laboratory, Vestry hall, Paddington, W.
July 25, 1879. Stone, E. M., Hill side, West hill, Sydenham, S.E.
May 23, 1879. Stubbins, John, F.G.S., F.R.M.S., Chester cottage, Old lane, Halifax.
May 23, 1879. Sturt, Clifton, King's college, W.C., and The University, Melbourne, Australia.
Sept. 23, 1881. Sturt, Gerald, 27, Gordon square, W.C.
July 7, 1865. Suffolk, W. T., F.R.M.S., Stettin lodge, St. Faith's road, Lower Norwood, S.E.
June 27, 1873. Suter, E. D., Parkfield, St. Andrew's park, Hastings.
June 24, 1870. Swain, Ernest, 34, Elsham road, Kensington, W.
Nov. 22, 1867. Swainston, J. T., 3, St. Mark's square, Regent's park, N.W.

Date of Election.	
Nov. 24, 1866.	Swansborough, E., 20, John street, Bedford row, W.C.
Dec. 17, 1875.	Swift, M. J., 81, Tottenham court road, W.C.
Jan. 23, 1880.	Symons, W. H., F.C.S., F.R.M.S., 2, Queen's terrace, St. John's wood, N.W.
July 27, 1877.	Tanqueray, A. C., Reid's Brewery, Theobald's road, E.C.
Sept. 28, 1877.	Tarrant, K. J., Litchford house, Hatch end, Pinner.
Nov. 28, 1879.	Tasker, J. G., 18, Junction road, Upper Holloway, N.
Aug. 22, 1879.	Tate, J. W., 6, Clarendon terrace, Brentford road, Turnham green, W.
May 22, 1868.	Tatem, J. G., Russell street, Reading.
Feb. 25, 1881.	Taylor, Thomas, M.R.C.S., L.A.C., Bocking, near Braintree, Essex.
Aug. 23, 1878.	Teasdale, Washington, F.R.M.S., Rosehurst, Headingley, Leeds.
Dec. 22, 1865.	Terry, J., 109, Borough road, S.E.
Aug. 23, 1872.	Terry, Thomas, 5, Austin friars, E.C.
May 23, 1879.	Thompson, I. C., F.R.M.S., Woodstock, Waverley road, Liverpool.
May 28, 1875.	Thomson, J. R., 15, Highbury place, Islington, N.
Feb. 24, 1871.	Thornthwaite, W. H., 416, Strand, W.C.
April 27, 1877.	Thorpe, George, 20, Eastcheap, E.C.
Jan. 22, 1875.	Tinney, W. A.
Nov. 27, 1867.	Tomkins, S. L., Apsley, East Grinstead.
June 23, 1871.	Topping, Amos, 28, Charlotte street, Caledonian road, N.
July 26, 1872.	Townsend, J. S., F.R.M.S., Stamford lodge, St. John's, Sevenoaks.
June 23, 1882.	Trinder, Stephen, 90, Morton road, Islington, N.
July 24, 1868.	Tulk, John A., M.D., F.R.M.S., Burton lodge, Staines road, Twickenham.
July 26, 1867.	Turnbull, J., Laurel house, North hill, Highgate, N.
Aug. 24, 1877.	Turner, E. B., 1, Clifton villas, Amberley road, Lea bridge road, N.E.
June 25, 1869.	Turner, R. D., Roughway, near Tonbridge.

Date of Election.	
June 25, 1875.	Turner, Sydney, A.R.I.B.A., 7, Mark lane, E.C.
Feb. 25, 1881.	Tyler, Charles, F.L.S., F.G.S., F.R.M.S., 317, Holloway road, N.
May 25, 1877.	Veasey, R. G., Ashchurch lodge, Ashchurch road, Shepherd's bush, W.
July 27, 1866.	Veitch, Harry, F.H.S., The Royal Exotic Nursery, King's road, Chelsea, S.W.
Feb. 28, 1879.	Venables, W., 253, Camden road, N.W.
Feb. 27, 1880.	Vereker, The Hon. J. G. P., 1, Portman square, W.
Feb. 25, 1881.	Vereker-Bindon, W. J., M D., F.R.C.S.E., 2, Elgin villas, Willesden lane, Kilburn, N.W.
May 23, 1879.	Vezey, J. J., F.R.M.S., 12, Sandbourne road, Brockley rise, S.E.
Mar. 24, 1882.	Vicars, John, 7, Hartington road, Liverpool.
June 25, 1880.	Waddington, H. J., 39, Gower street, W.C.
Feb. 27, 1874.	Walker, J. C., Highfield, Avenue road, Crouch end, N.
July 25, 1873.	Walker, J. S., Warwick road, Upper Clapton, E.
June 26, 1868.	Walker, J. W., Melrose villa, Watford.
May 22, 1868.	Waller, J. G., 68, Bolsover street, Portland road, W.
Jan. 23, 1880.	Wallis, Whitworth, 4, The Residences, South Kensington, S.W.
Aug. 26, 1870.	Warburton, Samuel, Merton villa, New road, Lower Tooting. S.W.
Nov. 22, 1867.	Ward, F. H., M.R.C.S., F.R.M.S., Springfield house, near Tooting, S.W.
Feb. 25, 1881.	Ward, J. D., Northwood lodge, Cowes, Isle of Wight.
June 28, 1878.	Ward, R. J., Silver street, Lincoln.
Dec. 18, 1868.	Warner, Alfred, care of Mr. W. F. Stanley, 13, Railway approach, London bridge, S.E.
May 25, 1866.	Warrington, H. R., 7, Royal Exchange, Cornhill, E.C.
Oct. 27, 1865.	Watkins, C. A., 10, Greek street, Soho, W.
Oct. 25, 1872.	Watkins, J., L.C.P., 24, Lime grove, Lewisham, S.E.
Aug. 23, 1878.	Watson, G. F., 313, High Holborn, W.C.
Nov. 28, 1879.	Watson, R. W., 22, Highbury new park, N.

Date of Election.	
Sept. 28, 1877.	Watson, T. P., F.R.M.S., 313, High Holborn, W.C.
Dec. 28, 1877.	Watson, T. W., 4, Pall Mall, S.W.
May 23, 1879.	Watts, The Rev. G. E., M.A., F.R.M.S., Kensworth vicarage, Dunstable, Herts.
Dec 28, 1866.	Way, T. E., Argyll road, Ealing, W.
Oct. 26, 1877.	Weatherley, Capt. H. C. S., 64, Cheapside, E.C.
July 24, 1874.	Webb, C. E., Wildwood lodge, North end, Hampstead, N.W.
April 25, 1879.	Webster, H. W., M.D., St. George's Infirmary, Fulham road, S.W.
May 24, 1867.	Weeks, A. W. G., 36, Gunter grove, West Brompton, S.W.
Sept. 27, 1878.	West, R. G., 39, Lombard street, E.C.
May 26, 1882.	Western, George E.
Feb. 25, 1876.	Wheeler, George, 27, Theberton street, N.
May 23, 1879.	Wheldon, John, F.R.M.S., 58, Great Queen street, Lincoln's Inn Fields, W.C.
Sept. 23, 1881.	Whelpton, E. S., B.A., Cantab., Boyland Oak, Streatham hill, S.W.
May 22, 1868.	White, T. Charters, M.R.C.S., L.D.S., F.L.S. F.R M.S. (*Past President, Vice-President*), 32, Belgrave road, S.W.
July 25, 1873.	White, Walter, Litcham, Norfolk.
Aug. 22, 1879.	Whittell, H. T., M.D., F.R.M.S., Aston villa, near Glenelg, South Australia.
June 25, 1880.	Wickes, W. D., 3, Cottage grove, Bow road, E.
Mar. 25, 1881.	Wildy, Arthur, 48, Albion road, South Hampstead, N.W.
April 23, 1880.	Williams, Arthur, 48, Osnaburg street, Regent's park, N.W.
July 28, 1882.	Williams, Benjamin, 3, Comberton road, Upper Clapton, E.
Mar. 24, 1871.	Williams, George, F.R.M.S., 135, Coningham road, Shepherd's bush, W.
Nov. 23, 1877.	Williams, G. S., 10, Clifton villas, Maida hill, W.
May 28, 1880.	Williams, J. M., The Hawthorns, Bootle, Liverpool.
June 27, 1879.	Willson, James, 2, Oval road, Regent's park, N.W.

Date of Election.	
Mar. 24, 1876.	Wilson, C. J., 14, Highbury crescent, N.
Feb. 22, 1867.	Wilson, Frank, 110, Long acre, W.C.
Jan. 24, 1879.	Wilson, S. K., F.R.G.S., F.R.M.S., M.R.I., 3, Portland terrace, Regent's park, N.W.
April 23, 1880.	Winney, H. J., 1, Shorters court, Throgmorton street, E.C.
June 27, 1879.	Wood, Francis, 63, Mayfield road, Dalston, E.
Aug. 27, 1869.	Woods, W. Fell, 1, Park hill, Forest hill, S.E.
Jan. 28, 1876.	Woollett, John, 58, Cloudesley road, Islington, N.
Oct. 25, 1867.	Worthington, Richard, Champion park, Denmark hill, S.E.
June 27, 1873.	Wrey, G. E. B., Addington house, Addington road, Reading.
Aug. 22, 1879.	Wright, B. M., 54, Guildford street, Russell square, W.C.
Nov. 26, 1880.	Wright, J. H., jun., Merston house, Ealing, W.
Nov. 25, 1881.	Wyatt, Robert, B.A., 7, Dunford road, N.
May 25, 1877.	Yates, Francis, Rockwood, Surbiton hill.
Jan. 25, 1878.	Yates, Robert, 64, Park street, Southwark, S.E.
Oct. 26, 1866.	Yeats, Christopher, Mortlake, Surrey, S.W.

NOTICE.

Members are requested to give the Hon. Secretary early information of any change of residence, so as to prevent miscarriage of Journals and Circulars.

RULES.

I.—That the Quekett Microscopical Club hold its Meetings at University College, Gower Street, on the fourth Friday Evening in every month, at Eight o'clock precisely, or at such other time or place as the Committee may appoint.

II.—That the business of the Club be conducted by a Committee, consisting of a President, four Vice-Presidents, an Honorary Treasurer, one or more Honorary Secretaries, an Honorary Secretary for Foreign Correspondence, an Honorary Reporter, an Honorary Librarian, an Honorary Curator, and twelve other Members,—six to form a quorum. That the President, Vice-Presidents, Treasurer, Secretaries, Reporter, Librarian, Curator, and the four senior Members of the Committee (by election) retire annually, but be eligible for re-election. That the Committee may appoint a stipendiary Assistant-Secretary, who shall be subject to its direction.

III.—That at the ordinary Meeting in June, nominations be made of Candidates to fill the offices of President, Vice-Presidents, Treasurer, Secretaries, Reporter, Librarian, Curator, and vacancies on the Committee. That the President, Vice-Presidents, Treasurer, Secretaries, Reporter, Librarian, and Curator, be nominated by the Committee. That the nominations for Members of Committee be made by the Members upon resolutions duly moved and seconded, no Member being entitled to propose more than one Candidate. That a list of all nominations made as above be printed upon the ballot paper; the nominations for vacancies upon the Committee being arranged in such order as shall be determined by lot, as drawn by the President and Secretary. That at the Annual General Meeting in July all the above Officers be elected by ballot from the Candidates named in the lists, but any Member is at liberty to substitute on his ballot-paper any other name or names in lieu of those nominated for the offices of President, Vice-Presidents, Treasurer, Secretaries, Reporter, Librarian, and Curator.

IV.—That in the absence of the President and Vice-Presidents, the Members present at any ordinary Meeting of the Club elect a Chairman for that evening.

V.—That every Candidate for Membership be proposed by two or more Members, who shall sign a certificate (see Appendix) in recommendation of him—one of the proposers from personal knowledge. The certificate shall be read from the chair, and the Candidate therein recommended balloted for at the following Meeting. Three black balls to exclude.

VI.—That the Club include not more than twenty Honorary Members, elected by the Members by ballot upon the recommendation of the Committee.

VII.—That the Annual Subscription be Ten Shillings, payable in advance on the 1st of July, but that any Member elected in May or June be exempt from subscription until the following July. That any Member desirous of compounding for his future subscription may do so at any time by payment of the sum of Ten Pounds; all such sums to be duly invested in such manner as the Committee shall think fit. That no person be entitled to the full privileges of the Club until his subscription shall have been paid; and that any Member omitting to pay his subscription six months after the same shall have become due (two applications in writing having been made by the Treasurer) shall cease to be a Member of the Club.

VIII.—That the accounts of the Club be audited by two Members, to be appointed at the ordinary Meeting in June.

IX.—That the Annual General Meeting be held on the fourth Friday in July, at which the Report of the Committee on the affairs of the Club, and the Balance Sheet duly signed by the Auditors shall be read. Printed lists of Members nominated for election as President, Vice-Presidents, Treasurer, Secretaries, Reporter, Librarian, Curator, and Members of the Committee having been distributed, and the Chairman having appointed two or more Members to act as Scrutineers, the Meeting shall then proceed to ballot. If from any cause these elections, or any of them, do not take place at this Meeting, they shall be made at the next Ordinary Meeting of the Club.

X.—That at the Ordinary Meetings the following business be transacted :—The minutes of the last Meeting shall be read and confirmed ; donations to the Club since the last Meeting announced and exhibited ; ballots for new Members taken ; papers read and discussed ; and certificates for new Members read ; after which the Meeting shall resolve itself into a Conversazione.

XI.—That any Member may introduce a Visitor at any Ordinary Meeting, who shall enter his name with that of the Member by whom he is introduced in a book to be kept for the purpose.

XII.—That no alteration be made in these Rules, except at an Annual General Meeting, or a Special General Meeting called for that purpose ; and that notice in writing of any proposed alteration be given to the Committee, and read at the Ordinary Meeting at least a month previous to the Annual or Special Meeting at which the subject of such alteration is to be considered.

APPENDIX.

Form of Proposal for Membership.

Quekett Microscopical Club.

Mr.
of
being desirous of becoming a Member of this Club, we beg to recommend him for election.

(*On my personal knowledge*).

This Certificate was read 18
The Ballot will take place 18

MEETINGS

OF THE

QUEKETT MICROSCOPICAL CLUB,

AT

UNIVERSITY COLLEGE, GOWER STREET, LONDON.

1882.—	August	11	25
	September	8	22
	October	13	27
	November	10	24
	December	8	22
1883.—	January	12	26
	February	9	23
	March	9	*
	April	13	27
	May	11	25
	June	8	22
	July	13	27

* March 23rd, Good Friday. No meeting.

The Ordinary Meetings are held on the *fourth* Friday in each month:—business commences at 8 o'clock p.m.

The Meetings on the *second* Friday in the month are for Conversation and Exhibition of Objects; from 7 to 9.30 p.m.

The Annual General Meeting will be held on July 27th, 1883, at 8 o'clock, for Election of Officers and other Business.

EXCURSIONS, 1882.

Mar. 11th. SNARESBROOK. Returning from George Lane Station. To meet at Liverpool Street and Fenchurch Street Stations.

Mar. 25th. HIGHGATE STATION, for ALEXANDRA PALACE. To meet at Moorgate Street and King's Cross Stations.

April 8th. EAST END, for FINCHLEY. To meet at Broad Street Station.

April 22nd. CATERHAM, for GODSTONE. To meet at Cannon Street Station.

May 6th. ESHER. To meet at Waterloo, Suburban Station.

May 20th. TOTTERIDGE. Returning by Mill Hill. To meet at Moorgate Street Station.

June 3rd. CHINGFORD. To meet at Liverpool Street Station.

June 10th. EXCURSIONISTS' ANNUAL DINNER. Arrangements will be duly announced.

June 17th. HAMPTON COURT. To meet at Waterloo, Suburban Station.

July 1st. SHEPPERTON, for WALTON. To meet at Waterloo, Loop Line Station.

July 15th. WEYBRIDGE. To meet at Waterloo, Main Line Station.

July 29th. DAY EXCURSION, WHITSTABLE. To meet at Holborn Viaduct Station, 10 a.m., or next later Train.

Aug. 5th. HOMERTON, for HACKNEY MARSHES. To meet at Homerton Station.

Aug. 19th. NORTHFLEET, for SWANSCOMBE. To meet at Cannon Street Station.

Sept. 9th. TAPLOW. To meet at Paddington Station.

Sept. 23rd. BROMLEY, for KESTON. To meet at Holborn Viaduct Station.

Oct. 7th. BARNES. To meet at Waterloo, Loop Line Station.

The time of departure from Town, unless otherwise specified, will be the First Train after TWO o'clock.

W. G. Cocks, F. Oxley,
E. Dadswell, W. W. Reeves,
F. W. Gay, T. Rogers,
J. Spencer,
Excursion Committee.

OFFICERS AND COMMITTEE.

(Elected July, 1883.)

President.

M. C. Cooke, M.A., LL.D., A.L.S.

Vice-Presidents.

A. D. Michael, F.L.S., F.R.M.S., &c.
E. T. Newton, F.G.S.
Charles Stewart, M.R.C.S., F.L.S., &c.
T. Charters White, M.R.C.S., L.D.S., &c.

Committee.

J. Matthews, M.D., F.R.M.S.
B. W. Priest.
J. G. Waller.
J. W. Groves, F.R.M.S.
J. D. Hardy, F.R.M.S
E. Jaques, B.A., F.R.M.S.
E. M. Nelson.
E. Dadswell.
Rev. H. J. Fase.
H. R. Gregory.
F. W. Hembry, F.R.M.S.
H. J. Waddington.

Hon. Treasurer.

F. W. Gay, F.R.M.S., 113, High Holborn, W.C.

Hon. Secretaries.

J. E. Ingpen, F.R.M.S., 7, The Hill, Putney, S.W.
G. C. Karop, M.R.C.S., 198, Holland Road, Kensington, W.

Hon. Sec. for Foreign Correspondence and Editor of Journal:

H. F. Hailes, 5, Richmond Villas, Middle Lane, Crouch End, N.

Hon. Reporter.

R. T. Lewis, F.R.M.S.

Hon. Librarian.

Alpheus Smith.

Hon. Curator.

Charles Emery.

PAST PRESIDENTS.

		Elected.
EDWIN LANKESTER, M.D., F.R.S. - -	July,	1865.
ERNEST HART - - - - -	„	1866.
ARTHUR E. DURHAM, F.R.C.S., F.L.S., &c.	„	1867.
„ „ „ „ - -	„	1868.
PETER LE NEVE FOSTER, M.A. - -	„	1869.
LIONEL S. BEALE, M.B., F.R.S., &c. - -	„	1870.
„ „ „ „ - -	„	1871.
ROBERT BRAITHWAITE, M.D., F.L.S., &c.	„	1872.
„ „ „ „ - -	„	1873.
JOHN MATTHEWS, M.D., F.R.M.S. - -	„	1874.
„ „ „ „ - -	„	1875.
HENRY LEE, F.L.S., F.G.S., F.R.M.S., F.Z.S.	„	1876.
„ „ „ „ - -	„	1877.
THOS. H. HUXLEY, LL.D., F.R.S., &c. - -	„	1878.
T. SPENCER COBBOLD, M.D., F.R.S., F.L.S., &c.		1879.
T. CHARTERS WHITE, M.R.C.S., F.L.S., &c.	„	1880.
„ „ „ „ - -	„	1881.
M. C. COOKE, M.A., LL.D., A.L.S. - -	„	1882.

HONORARY MEMBERS.

Date of Election.	
Jan. 24, 1868.	Arthur Mead Edwards, M.D., 120, Belleville avenue, Newark, New Jersey, U.S.A.
Mar. 19, 1869.	The Rev. E. C. Bolles, Salem, Mass., U.S.A.
July 26, 1872.	S. O. Lindberg, M.D., Professor of Botany, University of Helsingfors, Finland.
July 26, 1872.	Prof. Hamilton L. Smith, President of Hobart College, Geneva, New York, U.S.A.
July 26, 1872.	J. J. Woodward, Assist. Surgeon, U.S., Army War Department, Surgeon General's Office, Washington, U.S.A.
July 23, 1875.	Lionel S. Beale, M.B., F.R.S., F.R.M.S., &c. (*Past President*), 61, Grosvenor street, W.
Sept. 22, 1876.	Frederick Kitton, Hon. F.R.M.S., &c., 2, Bedford street, Unthanks road, Norwich.
July 25, 1879.	W. B. Carpenter, C.B., M.D., F.R.S., &c., &c., 56, Regent's park road, N.W.
July 25, 1879.	Dr. E. Abbe, University, Jena, Saxe Weimer, Germany.
July 23, 1880.	F. H. Wenham, C.E., 3, Gothic Villas, Warbeck road, Shepherd's Bush, W.
Nov. 24, 1882.	Dr. Veit B. Wittrock, Professor at the Royal Academy of Sciences, and Director of the Museum of Natural History, Stockholm, Sweden.

LIST OF MEMBERS.

Date of Election.	
Sept. 24, 1869.	Ackland, William, L.S.A., F.R.M.S., 416, Strand, W.C.
June 25, 1880.	Adams, C. A., 33, Loughborough park, Brixton, S.W.
Nov. 28, 1879.	Adams, S. C., 33, Telford avenue, Streatham Hill, S.W.
June 23, 1876.	Addis, W., 44, Herbert street, New North road, Hoxton, N.
Nov. 27, 1868.	Adkins, William, 268, Oxford street, W.
June 24, 1881.	Alabone, E. W., M.D., 175, Highbury New park, N.
Mar. 23, 1866.	Allbon, William, F.R.M.S., 37, Gloucester place, Portman square, W.
April 25, 1879.	Allen, E. H., 17, Carlisle street, Soho square, W.
June 23, 1876.	Allison, Charles, 18, Ravenstone road, Hornsey, N.
July 26, 1872.	Alstone, John, 3, Great Tower street, E.C.
Dec. 17, 1869.	Ames, G. A., F.R.M.S., Union Club, Trafalgar square, W.C.
Sept. 25, 1868.	Andrew, A. R., 1, St. George's villas, Middleton road, Hornsey, N.
Dec. 22, 1865.	Andrew, F. W., 3, Neville terrace, Onslow gardens, S.W.
Aug. 22, 1879.	Arch, A. J. E., 20, Sydenham park, S.E.
May 28, 1875.	Arrowsmith, Wastell, 99, Adelaide road, Haverstock hill, N.W.
June 22, 1883.	Ash, George C., 141, Maida Vale, W.
July 25, 1879.	Ashbridge, Arthur, 76, Leadenhall street, E.C.
Sept. 27, 1878.	Ashby, H. T., 8, Bartholomew road, Kentish town, N.W.
June 26, 1874.	Badcock, John, F.R.M.S., 270, Victoria park road, South Hackney, E.

Date of Election.	
Dec. 27, 1867.	Bailey, J. W., 75, Broke road, Dalston, E.
April 24, 1868.	Baker, Charles, F.R.M.S., 244, High Holborn, W.C.
May 25, 1877.	Baker, G. L., 15, Windsor road, Denmark hill, S.E.
Feb. 25, 1876.	Ballard, Dr. W. R., jun., 26, Manchester square, W.
June 22, 1883.	Balleine, Arthur Edwin, 3, Mecklenburg street, Mecklenburg square, W.C.
Jan. 24, 1879.	Barham, G. T., Danehurst, Hampstead, N.W.
July 28, 1876.	Barnard, Henry.
Dec. 27, 1872.	Barnard, Herbert, 33, Portland place, W.
April 22, 1870.	Barnes, C. B., 4, Egremont villas, White horse lane, South Norwood, S.E., and 27, Clement's lane, E.C.
July 27, 1883.	Barnes, Henry, Patschull house, Dartmouth Park avenue, N.
Aug. 28, 1874.	Barnett, E.W.
May 25, 1883.	Barratt, Thomas, Bell Moor House, Upper Heath, Hampstead, N.W.
Sept. 27, 1872.	Bartlett, Edward, jun., L.D.S., M.R.C.S.E., 40, Elgin road, St. Peter's park, W.
Dec. 28, 1877.	Batchelor, J. A., Avenue road, Bexley, Kent.
May 22, 1874.	Bate, G. P., M.D., F.R.C.S.E., F.R.M.S., 412, Bethnal green road, E.
Mar. 27, 1874.	Beach, R. J., 36, Eden grove, Hornsey, N.
Jan. 25, 1878.	Beaman, G. H.
May 28, 1869.	Bean, C. E., Brooklyn house, Goldhawk road, Shepherd's bush, W.
Feb. 28, 1879.	Bear, John.
Nov. 26, 1875.	Beaulah, John, Raventhorpe, Brigg.
May 24, 1878.	Beddard, F. E.
May 26, 1871.	Bedwell, F. A., M.A. Cantab, F.R.M.S., Fort Hall, Bridlington quay, Yorkshire.
Mar. 24, 1871.	Bentley, A. R., 36, Portland place, W.
May 22, 1868.	Berney, John, F.R.M.S., 61, North end, Croydon.
Oct. 23, 1868.	Bevington, W. A., F.R.M.S., 80, Avondale square, Old Kent road, S.E.
Mar. 28, 1879.	Bird, F. E., 42, Overton road, Brixton, S.W.
July 28, 1871.	Bishop, William, 549, Caledonian road, N.

Date of Election.	
May 27, 1881.	Bishopp, O. S., F.R M.S., Oak villa, Muswell hill, N.
Feb. 23, 1866.	Blake, T., 6, Charlotte terrace, Brook green, Hammersmith, W.
Mar. 19, 1869.	Blankley, Frederick, F.R.M.S., Brightholm, Oakfield road, Upper Tollington park, N.
July 27, 1877.	Blenkinsop, Benjamin, 176, Queen Victoria street, E.C.
May 26, 1876.	Blundell, Joseph, 24, Davies street, Berkeley square, W.
Jan. 25, 1878.	Bogue, David, F.R.M.S., 3, St. Martin's place, Trafalgar square, W.C.
Dec. 27, 1881.	Bolton, J. G. E., M.R.C.S., Savanne, Mauritius,
Jan. 22, 1875.	Bolton, Thomas, F.R.M.S., 57, Newhall street. Birmingham.
Jan. 24, 1879.	Bond, R. C. C., 36, Keppell street, Russell square, W.C.
April 22, 1870.	Bossy, A. H., 118, Stoke Newington road, N.
May 27, 1881.	Botterill, Charles, 13, Bentley road, Liverpool.
Feb. 24, 1882.	Bound, H. J., 19, Torrington square, W.C.
Oct. 27, 1865.	Braithwaite, Robert, M.D., M.R.C.S.E., F.L.S., F.R.M.S., (*Past President*), The Ferns, 303, Clapham road, S.W.
June 28, 1878.	Brewster, W., 25, Myddelton square, E.C.
May 26, 1876.	Brigstock, J. W., 4, Comberton road, Upper Clapton, E.
Oct. 27, 1883.	Brown, Fredk. Wm., 3, Walterton road, St. Peter's park, W.
May 27, 1870.	Brown, G. D., M.R.C.S., Henley villa, Uxbridge road, Ealing, W.
Sept. 26, 1879.	Brown, William, B.Sc., 3, Elm cottages, Middle lane, Hornsey, N.
May 22, 1868.	Brown, W. J., 1, Lorne villas, Stodart road, Anerley.
May 26, 1871.	Browne, George, 45, Victoria road, Kentish town, N.W.
May 28, 1875.	Browne, J. W., Frascati, Masons hill, Bromley, Kent.
Feb. 27, 1872.	Browne, Rev. T. H., F.R.M.S., F.G.S., M.E.S., High Wycombe, Bucks.

Date of Election.	
Jan. 23, 1880.	Browne, W. R., 90, Morton road, Islington, N.
Dec. 22, 1883.	Bucknall, Edward, 16, Junction road, Highgate, N.
Jan. 26, 1877.	Buffham, T. H., 2, Connaught road, Walthamstow.
June 22, 1883.	Burbidge, William Henry, Stanley House, Alleyn park, Dulwich, S.E.
Aug. 22, 1879.	Burton, William, 27, Wigmore street, W.
May 23, 1879.	Button, Arthur, 2a, St. Paul's road, Camden square, N.W.
June 14, 1865.	Bywater, W. M., F.R.M.S., 5, Hanover square, W.
Nov. 22, 1878.	Cafe, J. W., 46, Clifton hill, St. John's wood, N.W.
June 25, 1880.	Cambridge, John, Bury St. Edmunds, Suffolk.
June 23, 1882.	Campbell, Thomas, The India Office, S.W.
Sept. 22, 1876.	Canton, Frederick, L.R.C.P., M.R.C.S., &c., 17, Great Marlborough street, Regent street, W.
May 23, 1879.	Carpenter, H.S., F.R.M.S., Beckington house, Weighton road, Anerley, S.E.
July 23, 1880.	Carr, Ebenezer, 26, Bromar road, Denmark park, S.E.
Nov. 24, 1882.	Carr, Thomas, M.R.C.S., Guy's Hospital, S.E.
April 25, 1879.	Cazaux, D. B., F.R.M.S., 4, Adolphus road, Finsbury park, N.
April 25, 1879.	Chantrell, G. F., F.R.M.S., 1, St. James's mount, Liverpool.
May 26, 1882.	Chapman, W. Ingram, 2, Commercial Sale rooms, Mincing lane, E.C.
Dec. 27, 1878.	Chatto, Andrew, 214, Piccadilly, W.
Nov. 27, 1874.	Chippindale, George, Grape villa, Rothschild road, Chiswick High road, W.
Dec. 27, 1881.	Claremont, Claude Clarke, M.R.C.S., Millbrooke house, Hampstead, N.W.
Feb. 23, 1883.	Clark, Joseph, Street, Somerset.
Oct. 25, 1878.	Clifford, Rev. H. M., M.A.
Aug. 27, 1880.	Close, J. A., 449, Strand, W.C.
July 25, 1879.	Cobbold, T. S., M.D., F.R.S., F.L.S. (*Past President*), 74, Portsdown road, Maida vale, W.
May 22, 1868.	Cocks, W. G., 36, Gayhurst road, Dalston, E.
Nov. 25, 1881.	Coffin, Walter H., F.L.S., F.C.S., F.R.M.S., &c., 94, Cornwall gardens, South Kensington, S.W.

Date of Election.	
Sep. 22, 1876.	Cole, A. C., F.R.M.S., St. Domingo house, Oxford gardens, Notting hill, W.
Nov. 27, 1874.	Cole, B. G., Laurel cottage, King's place, Buckhurst hill, Essex
April 24, 1874.	Cole, William, M.E.S., *Hon. Secretary Essex Naturalists' Field Club*, Laurel cottage, King's place, Buckhurst hill, Essex.
Jan. 25, 1867.	Coles, Ferdinand, F.L.S., 18, Brooks road, Stoke Newington common, N.
Mar. 24, 1876.	Colsell, G. D., 2, Royal Exchange buildings, E.C.
Sept. 27, 1872.	Connolly, C. T., L.S.A., 3, Church hill villas, Wood green, N.
June 14, 1865.	COOKE, M. C., M.A., LL.D., A.L.S. (*President*), 146, Junction road, Upper Holloway, N.
Feb. 22, 1867.	Cooper, F. W., L.R.C.S. Edin., Leytonstone, E.
June 27, 1873.	Corbett, A. L., 103, Fentiman road, Clapham road, S.W.
May 28, 1869.	Cottam, Arthur, F.R.A.S., H.M. Office of Woods, Whitehall place, S.W.
July 26, 1872.	Cowan, T. W., F.G.S., F.R.M.S., Comptons lea, Horsham, Sussex.
Aug. 28, 1868.	Crisp, Frank, LL.B., B.A., *V.P. and Treas. Linnean Society ; Hon. Sec. Royal Microscopical Society*, 5, Lansdowne road, Notting hill, W.
Dec. 23, 1870.	Crisp, J. S., F.R.M.S., Ashville, Lewin road, Streatham, S.W.
July 26, 1878.	Crockford, Wm., 2, St. Peter's road, Mile end, E.
Feb. 23, 1877.	Crofton, Edward, M.A. Oxon., F.R.M.S., 45, West Cromwell road, South Kensington, S.W.
June 24, 1881.	Crosby, H. T., 21, Gordon square, W.C.
Sept. 28, 1866.	Crouch, Henry, F.R.M.S., 66, Barbican, E.C.
June 22, 1877.	Cunliffe, P. G., F.R.M.S., The Elms, Handforth, Manchester.
June 25, 1880.	Curties, C. L., 244, High Holborn, W.C.
May 25, 1866.	Curties, Thomas, F.R.M.S., 244, High Holborn, W.C.
June 25, 1880.	Curties, W. I., 244, High Holborn, W.C.
Sept. 26, 1879.	Curtis, Charles, 29, Baker street, Portman sq., W.
Aug. 22, 1879.	Cuttell, F. G., 52, New Compton street, Soho, W.
April 22, 1881.	Cutting, W. M., 1, Curtain road, E.C.

Date of Election.	
Jan. 22, 1875.	Dadswell, Edward, 42, Barrington road, Stockwell, S.W.
Mar. 24, 1882.	Dale, Bernard, 14, Elm grove, Lee, Kent.
Nov. 23, 1877.	Dallas, W. S., F.L.S., &c., the Geological Society, Burlington house, Piccadilly, W.
Feb. 23, 1883.	Dallinger, Rev. W. H., F.R.S., F.R.M.S., Wesley college, Sheffield.
May 23, 1879.	Dallmeyer, T. R., 19, Bloomsbury street, W.C.
Mar. 22, 1878.	Darby, the Ven. Archdeacon, St. Bridget's rectory, Chester.
Mar. 22, 1878.	Darke, Edward, 16, Rochester terrace, Camden road, N.W.
May 23, 1874,	Davey, R. F., War Office, Pall Mall, S.W.
Oct. 22, 1869.	Davis, Henry, 19, Warwick street, Leamington.
May 23, 1879.	Dawson, William, 24, Abbeygate street, Bury St. Edmunds, Suffolk
May 28, 1875.	Dean, Arthur (*Hon. Sec. East Lond. Mic. Soc.*), 12, Vernon road, Tredegar road, Bow, E.
Feb. 23, 1877.	Death, James, jun., 38, Gladstone street, St. George's road, Southwark, S.E.
Feb. 28, 1879.	Debenham, E. H., 9, Mincing lane, E.C.
Jan. 24, 1879.	Deby, Julien, C.E., F.R.M.S., 75, Holland road, Kensington, W.
Nov. 24, 1876.	Despointes, Francis, 16, St. George's square, Regent's park road, N.W.
Nov. 25, 1881.	Dixon, George S., 4, Brooklyn road, Shepherd's bush road, W.
May 23, 1879.	Dixon, W. F., 18, University street, W.C.
Nov. 24, 1865.	Dobson, H. H., F.R.M.S., Holmesdale, Grange park, Ealing, W.
Nov. 27, 1868.	Douglas, Rev. R. C., Manaton rectory, Moretonhampstead, Exeter.
Oct. 25, 1878.	Dowler, Captain F. E., Naval and Military Club, Piccadilly, W.
Jan. 23, 1880.	Dowsett, G. H., 11, Gloucester place, Greenwich, S.E.
May 25, 1883.	Drake, C. A., The Distillery, Three Mill lane, Bromley-by-Bow.
Nov. 22, 1878.	Drayton, H. F. E., Horton house, Beckenham, Kent.
July 25, 1879.	Driver, Alfred, 30, Leigham court road West, Streatham, S.W.

Date of Election.

Aug. 26, 1872. Dudgeon, R. E., M.D., 53, Montagu square, W.
Oct. 25, 1872. Dunning, C. G., 55, Camden park road, N.W.
Sept. 22, 1865. Durham, A. E, F.R.C.S., F.L.S., F.R.M.S., &c. (*Past President*), 82, Brook street, Grosvenor square, W.
July 27, 1883. Durrand, Alexander, 5, Philbrick terrace, Nunhead lane, Peckham Rye, S.E.

Jan. 24, 1879. Easty, C. W., 19, Edith road, St. Mary's road, Peckham, S.E.
Sept. 25, 1868. Eddy, J. R., F.R.M.S., F.G.S., The Grange, Carleton, Skipton, Yorkshire.
June 28, 1867. Edmonds, R., 178, Burrage road, Plumstead, S.E.
May 26, 1876. Emery, Charles (*Hon. Curator*), 6, Laburnum cottages, Middle lane, Crouch end, N.
May 26, 1871. Enock, Frederick, Ferndale, Bath road, Woking Station.
Feb. 28, 1879. Epps, Hahnemann, 9, Eliot bank, Sydenham hill, S.E.
Dec. 27, 1878. Erlebach, H. A., Mill hill school, Mill hill, N.W.
Feb. 25, 1881. Essell, G. F. S., Christ Church vicarage, Spa road, Bermondsey, S.E.

Dec. 17, 1875. Farries, Thomas, F.C.S.
July 25, 1873. Fase, Rev. H. J., 5, Bessborough gardens, S.W.
June 25, 1875. Faulkner, Henry, jun., Fernwood, Roehampton park, S.W.
Jan. 28, 1876. Faulkner, John, 20, Mornington crescent, N.W.
Feb. 27, 1880. Fieldwick, Alfred, jun., 284, Dalston lane, Hackney, E.
July 22, 1881. Firth, W. A., Whiterock, Belfast.
Feb. 24, 1882. Fitch, J. Nugent.
July 26, 1867. Fitch, Frederick, F.R.G.S., F.R.M.S., Hadleigh house, Highbury New park, N.
Nov. 28, 1879. Forster, William, jun., Cleveland road, Woodford, Essex.
Mar. 24, 1871. Foulerton, John, M.D., Science club, 4, Savile row, W.
July 26, 1878. Fowke, Francis, F.R.M.S., 40, Nottingham place, W.

Date of Election	
Dec. 28, 1866.	Fox, C. J., F.R.M.S., 26, South Molton street, Oxford street, W.
Nov. 26, 1875.	Freckelton, Rev. T. W., F.R.M.S., 28A, Lonsdale square, Islington, N.
Jan. 23, 1880.	Freeland, F. J., M.R.C.S., J.P., North street, Chichester.
June 23, 1871.	Freeman, H. E., 60, Plimsoll road, Finsbury park, N.
May 22, 1868.	Fryer, G. H., 107, Belsize road, N.W.
July 23, 1880.	Funston, James, 93, Finsbury pavement, E.C.
June 23, 1882.	Garden, Alexander, M.D., Brigade Surgeon, 16, Aynhoe road, West Kensington park, W.
Mar. 25, 1870.	Garden, R. S., 42, Carlton hill, St. John's wood, N.W.
Feb. 26, 1875.	Gardner, Edmund, 454, Strand, W.C.
July 27, 1877.	Gardner, J. H., A.K.C., 44, Berners street, W.
April 24, 1868.	Garnham, John, F.R.M.S., Hazlewood crescent road, St. John's, Upper Lewisham, S.E.
April 23, 1880.	Gates, G. W. H., 21, Lombard street, E.C.
July 7, 1865.	Gay, F. W., F.R.M.S. (*Hon. Treasurer*), 113, High Holborn, W.C.
June 25, 1880.	George, C. F., M.R.C.S., Kirton-in-Lindsey, Lincolnshire.
July 26, 1867.	George, Edward, F.R.M.S., 12, Derby villas, Forest hill, S.E.
April 26, 1878.	Gibbins, G. W.
July 22, 1870.	Gibson, J. F., F.R.M.S., Clovelly, Lancaster road, Lower Norwood, S.E.
June 14, 1865.	Gibson, W., 3, Bridge street, Westminster, S.W.
April 27, 1877.	Gilbertson, Henry, Mangrove house, Hertford.
June 24, 1881.	Gilburt, Henry, 63, Rectory road, Stoke Newington, N.
Oct. 27, 1876.	Gilburt, W. H., F.R.M.S., 48, Wetherell road, South Hackney, E.
Feb. 25, 1881.	Glaisher, James, F.R.S., F.R.A.S., F.R.M.S., &c., 1, Dartmouth place, Blackheath, S.E.
June 27, 1873.	Glasspoole, H. G., 15, Mall road, Hammersmith, W.
Nov. 28, 1879.	Goodinge, A. C., 119, High Holborn, W.C.

Date of Election.	
April 26, 1872.	Goodinge, J. W., F.R.G.S., F.R.M.S., 119, High Holborn, W.C.
Nov. 23, 1877.	Goodwin, William, 24, Miranda road, Upper Holloway, N.
July 27, 1883.	Goold, Ernest H., C.E., F.Z.S., M.R.I., 4, Dane's Inn, Strand, W.C.
Mar. 27, 1866.	Gray, S. O., Bank of England, E.C.
Nov. 27, 1874.	Grayling, J. F., Sittingbourne, Kent.
May 22, 1874.	Green, G., 6, Helmet row, St. Luke's, E.C.
April 22, 1881.	Green, J. R.
Aug. 22, 1879.	Greenhough, D. W., F.R.M.S., South bank, Breakspeare road, Lewisham high road, S.E.
Feb. 24, 1882.	Greening, Linnæus, Birch house, Warrington.
Oct. 23, 1868.	Greenish, Thomas, F.R.M.S., 20, New street, Dorset square, N.W.
Oct. 23, 1868.	Gregory, H. R., 1, Wellington square, King's road, Chelsea, S.W.
April 27, 1883.	Gregory, William, 98, Brockley road, St. John's, S.E.
July 24, 1868.	Groves, J. W., F.R.M.S., 90, Holland road, Kensington, W., and Physiological Laboratory, King's College, W.C.
May 28, 1880.	Groves, William, 28, Manor park, Lee, S.E.
July 24, 1868.	Grubbe, E. W., C.E., 73, Redcliffe gardens, S.W.
Jan. 27, 1871.	Guimaraens, A. de Souza, F.R.M.S., 50, Lowden road, Herne hill, S.E.
Jan. 23, 1874.	Hadland, J. H., 11, King William street, E.C.
Sept. 28, 1877.	Hagger, John, Repton school, Burton-on-Trent.
Feb. 25, 1881.	Haigh, William, Tempsford villa, Uxbridge road, Ealing, W.
June 14, 1865.	Hailes, H. F. (*Hon. Secretary for Foreign Correspondence and Editor*), 5, Richmond villas, Middle lane, Crouch end, N.
Aug. 26, 1870.	Hailstone, R. H., 91, Adelaide road, N.W.
Feb. 23, 1867.	Hainworth, William, 3, Pembury road, Clapton, E.
July 28, 1876.	Halford, Edward, 18, Leinster square, Bayswater, W.
Dec. 28, 1866.	Hallett, R. J., 123, Seymour street, Euston square, N.W.
Feb. 22, 1869.	Hammond, A., F.L.S., 70, Finsbury park road, N.

Date of Election.

June 25, 1880. Hancock, H. S. H., 50, Springdale road, Stoke Newington, N.
Jan. 24, 1879. Harding, Burcham, 128, Adelaide road, N.W.
Feb. 24, 1882. Harding, J. H., 4, Finsbury square, E.C.
July 23, 1880. Hardingham, A. S., 59, St. George's square, S.W.
July 25, 1879. Hardingham, G. G., F.R.M.S., 33, St. George's square, S.W.
Jan. 23, 1874. Hardy, J. D., F.R.M.S., 73, Clarence road, Clapton, E., and 4, Lombard street, E.C.
Sept. 28, 1866. Harkness, W., F.R.M.S,, Laboratory, Somerset house, W.C.
June 23, 1871. Harris, Edward, F.R.M.S., Rydal villa, Longton grove, Upper Sydenham, S.E.
Jan. 25, 1878. Harrison, D. H., Argyll villas, Mattock lane, Ealing, W.
April 23, 1875. Harrison, James, 150, Akerman road, North Brixton, S.W.
July 26, 1872. Harrod, John, Mark lane square, E.C.
Mar. 28, 1879. Hawkins, C. E., H.M. Geological Survey, Jermyn street, S.W.
June 28, 1867. Hawksley, T. P., 97, Adelaide road, N.W.
June 22, 1883. Hazelwood, Jas. Edmund, F.R.M.S., 3, Lennox place, Brighton.
Sept. 28, 1877. Headley, Robert, F.R.G.S., 44, Walham grove, Walham green, S W.
Aug. 23, 1872. Hembry, F. W., F.R.M.S. (*Hon. Sec., S. Lond. Mic. and. Nat. Hist. Soc.*), Home Lea, Hatherley road, Sidcup, Kent.
June 26, 1868. Henry, A. H , 73, Redcliffe gardens, S.W.
Sept. 23, 1881. Hensoldt, Heinrich, 7, Machell road, Nunhead, S.E.
Dec. 22, 1882. Hilditch, James Bracebridge, Asgill house, Richmond, Surrey.
June 22, 1877. Hill, R. W., 41, Lothbury, E.C.
Sept. 24, 1869. Hilton, T. D., M.D., Upper Deal, Kent.
Sept. 28, 1866. Hind, F. H. P., Bartholomew house, Bartholomew lane, E.C.
May 22, 1874. Hind, George, 244, High Holborn, W.C.
July 26, 1872. Hinton, Ernest.
Aug. 26, 1870. Hirst, John, F.R.M.S., Ladcastle, Dobcross, Manchester.

Date of Election.	
Feb. 26, 1875.	Holford, Christopher, Bounty Office, Dean's yard, Westminster, S.W.
Jan. 23, 1880.	Holland, C. F., 14, Wayland avenue, Sandringham road, Hackney, E.
April 26, 1867.	Hooton, Charles, Sunningdale house, Bickerton road, Upper Holloway, N.
Nov. 26, 1880.	Hopkins, Robert, Shearn villa, Walthamstow, Essex.
April 28, 1876.	Horn, W. E., A.I.C.E., 10, Vincent square, Westminster, S.W.
Oct. 26, 1866.	Horncastle, Henry, Cobham, near Woking station
June 25, 1869.	Houghton, W., Hoe street, Walthamstow, E.
May 22, 1874.	Hovenden, C. W., F.R.M.S., 65, Rue de Faubourg, Poissonier, Paris.
April 26, 1867.	Hovenden, Frederick, F.R.M.S., Glenlea, Thurlow park road, Dulwich, S.E.
June 23, 1876.	How, W. S., 75, Great Portland street, W.
Oct. 27, 1876.	Howard, D., 60, Belsize park, N.W.
Oct. 25, 1878.	Howling, W. E., Crowley's Brewery, Alton, Hants.
Feb. 25, 1870.	Hudleston, W. H., J.P., F.G.S., 23, Cheyne walk, S.W.
Nov. 28, 1879.	Hughes, R. J., L.R.C.P., L.R.C.S., L.M.
Jan. 23, 1880.	Hunt, Frederick, York lodge, Stamford hill, N.
Dec. 28, 1866.	Hunt, W. H. B., F.R.M.S., 160, Camden road, N.W.
Dec. 22, 1876.	Hunter, J. J., 20, Cranbourne street, W.C.
July 25, 1873.	Hurst, J. T., Royal Engineer Office, Portsmouth.
June 28, 1878.	Huxley, Prof. T. H., F.R.S., &c. (*Past President*), Science Schools, South Kensington, S.W.
May 24, 1867.	Ingpen, J. E., F.R.M.S. (*Hon. Secretary*), 7, The hill, Putney, S.W.
Dec. 17, 1875.	Jackson, C. L., F.L.S., F.Z.S., F.R.M.S., Hill Fold, Sharples, Bolton.
July 24, 1868.	Jackson, F. R., Culver cottage, Slindon, Arundel, Sussex.
June 25, 1880.	Jacques, Walter, 2, Fenchurch buildings, E.C.

Date of Election.	
Aug. 25, 1882.	Jakeman, Christopher, 8, South villas, South street, Greenwich.
June 14, 1865.	Jaques, Edward, B.A., F.R.M.S., H.M. Office of Woods, Whitehall place, S.W.
Feb. 28, 1873.	Jenkins, J. W., 3, Harcourt road, Wallington.
July 24, 1868.	Jennings, Rev. Nathaniel, M.A., F.R.A.S., 8, Broadhurst gardens, South Hampstead, N.W.
Feb. 24, 1871.	Johnson, M. Hawkins, F.R.M.S., F.G.S., 379, Euston road, N.W.
June 23, 1876.	Johnson, T. R.
Feb. 23, 1877.	Johnston, J. M. C.
Mar. 24, 1871.	Johnstone, James, Stanhope lodge, Bideford.
Feb. 28, 1873.	Jones, G. J., Gainsborough house, Lymington.
June 25, 1875.	Jones J. B., F.R.M.S., St. George's Chambers, 10, St. George's crescent, Liverpool.
Nov. 25, 1870.	Jones, Lieut.-Col. Lewis, Westgate-on-Sea, Isle of Thanet.
May 23, 1873.	Jones, Captain L. F., United Service Club, Pall Mall, S.W.
June 23, 1876.	Jones, T. E., 46, Park street, Stoke Newington, N.
Jan. 27, 1882.	Jones, Rev. T. R., M.A., Codicote Vicarage, Welwyn, Herts.
May 23, 1873.	Karop, G. C., M.R.C.S., &c. (*Hon. Secretary*), 198, Holland road, Kensington, W.
Aug. 23, 1867.	Kiddle, Edward, 1, Cleveland villas, Rosemount road, Richmond hill, S.W.
Mar. 19, 1869.	Kilsby, T. W., 4, Brompton villas, Edmonton.
April 22, 1881.	King, H. W., The Cedars, Upper Park road, New Southgate, N.
Dec. 23, 1870.	King, Robert, F.R.M.S., Fern house, Upper Clapton, E.
May 24, 1878.	King, W. T., M.D., M.R.C.S., 74, Victoria park road, South Hackney, E.
Nov. 26, 1880.	Kingsett, C. T., F.C.S., F.I.C.
Feb. 28, 1873.	Kitsell, F. J., 24, St. Stephen's avenue, Goldhawk road, Shepherd's Bush, W.
Mar. 23, 1877.	Kluht, H. J., 42, Westbourne grove, Bayswater, W.
Oct. 24, 1873.	Knight, J. M., 50, Bow road, E.

Date of Election.	
Nov. 25, 1870.	Ladd, William, F.R.A.S., F.R.M.S., Claremont villa, Rectory road, Beckenham, Kent.
Jan. 24, 1879.	Lancaster, A. H., 7, Campden hill gardens, Kensington, W.
Mar. 22, 1867.	Lancaster, Thomas, Bownham house, Stroud, Gloucestershire.
Jan. 28, 1881.	Lankester, H. H., Medical School, St. Thomas' hospital
May 28, 1875.	Larkin, John, 24, Charterhouse square, E.C.
Nov. 26, 1880.	Larking, R. J., 98, Clarence road, Lower Clapton, E.
June 25, 1869.	Layton, C. E., 12, Upper Hornsey rise, N.
Aug. 28, 1868.	Leaf, C. J., F.L.S., F.R.M.S., &c. (*President of the Old Change Microscopical Society*), Old Change, E.C.
Mar. 19, 1869.	Lee, Henry, F.L.S., F.R.M.S., &c., (*Past President*), Ethelbert house, Margate.
Feb. 25, 1881.	Leicester, Alfred, Lynwood, Harbord street, Waterloo, near Liverpool.
Oct. 25, 1867.	Leifchild, J. R., M.A., 6, St. Lawrence road, Notting hill, W.
Sept. 22, 1865.	Leighton, W. H., 2, Merton place, Chiswick, W.
July 25, 1873.	Le Pelley, Charles, 84, St. Thomas' road, Seven Sister's road, N.
April 27, 1866.	Lewis, R. T., F.R.M.S. (*Hon. Reporter*), 1, Masbro' road, Brook green, W.
June 26, 1868.	Lindley, W. H., jun., 29, Blittersdorffs platz, Frankfort-on-Maine.
May 26, 1871.	Locke, John, 16, Georgiana street, Camden town, N.W.
April 23, 1869.	Long, Henry, 90, High street, Croydon.
Nov. 24, 1866.	Lovibond, J. W., F.R.M.S., St. Anne street, Salisbury.
Sept. 22, 1866.	Lovick, T., 53, Queen's crescent, Haverstock hill, N.W.
April 27, 1866.	Loy, W. T., F.R.M.S., Five Oaks, Billingshurst, Sussex.
Nov. 23, 1866.	McIntire, S. J., F.R.M.S., 14, Hettley road, Uxbridge road, Shepherd's bush, W.

Date of Election.	
Jan. 28, 1881.	McKenzie, J. A., The Warren, Loughton, Essex.
Jan. 23, 1880.	Mackenzie, James, Warden villa, Uxbridge road, Ealing, W.
April 27, 1883.	McManis, Thos. John, 28, Northcote street, Walthamstow, E.
June 28, 1878.	Magor, J. B., L.D.S., 24, Chapel street, Penzance.
July 26, 1874.	Magor, Thomas, M.D., Eagle cottage, Hornsey, N.
May 25, 1883.	Mainland, G. E., 115, Forest road, Dalston, E.
May 25, 1883.	Mais, H. T. Coathorpe, M.I.C.E., Engineer in Chief, Adelaide, South Australia.
Sept. 27, 1872.	Manning, H. E. the Cardinal Archbishop, Archbishop's house, Westminster, S.W.
July 27, 1883.	Mansfield, Edward Joseph, 176, Evering road, Upper Clapton, E.
Jan. 23, 1880.	Martin, Francis, R.N., Shrub cottage, Fairfield road, Old Charlton, Kent.
Sept. 22, 1876.	Martin, W. H., 11, Markham square, Chelsea, S.W.
Dec. 27, 1867.	Martinelli, A., 57, Prince of Wales crescent, Haverstock hill, N.W.
April 26, 1867.	Matthews, G. K., St. John's lodge, Beckenham, Kent.
Oct. 26, 1866.	Matthews, John, M.D., F.R.M.S. (*Past President*), 30, Colebrooke row, Islington, N.
May 26, 1871.	May, J. W., F.R.M.S., Arundel house, Percy cross, Fulham, S.W.
Feb. 27, 1874.	May, L. J., 371, Holloway road, N.
Dec. 17, 1875.	May, Thomas.
Feb. 25, 1876.	May, W. R., 52, Malvern road, Dalston, E.
Mar. 22, 1867.	Meacher, J. W., 10, Hillmarten road, Camden road, N
Feb. 28, 1879.	Menzies, James, 13, Leighton grove, N.W.
May 22, 1874.	Messenger, G. A., 31, Glengall road, Old Kent road, S.E.
July 27, 1877.	Michael, A. D., F.L.S., F.R.M.S., (*Vice President*), 3 and 4, Great Winchester street, E.C.

Date of Election.

May 28, 1880. Miles, Andrew, 185, Camden road, Peckham, S.E.

Sept. 22, 1882. Miles, Wm. Hy., 33, Paris street, Lambeth, S.E.

Feb. 25, 1881. Millar, John, L.R.C.P., F.L.S., F.R.M.S., Bethnal house, Cambridge road, E.

July 7, 1865. Millett, F. W., F.R.MS., Marazion, Cornwall.

Oct. 22, 1880. Milner, W. E., 47, Park road, Haverstock hill, N.W.

Sept. 22, 1882. Moore, George, 7, Draper's gardens, Throgmorton street, E.C.

Jan. 23, 1874. Moreland, Richard, jun., M.I.C.E., F.R.M.S., 4, The Quadrant, Highbury, N.

July 26, 1878. Morland, Henry, Cranford, near Hounslow.

Oct. 27, 1866. Morrieson, Colonel R., F.R.M.S., Oriental Club, Hanover square, W.

Dec. 27, 1876. Morris, J. G., M.R.C.S., 135, St. Owen street, Hereford.

Oct. 27, 1876. Morris, W. G., L.D.S., The Lodge, Sansome walk, Worcester.

Nov. 23, 1877. Morten, T. S., 42, Haverstock hill, N.W.

Jan. 24, 1879. Murray, James, Osborne house, 50, Percy road, Shepherd's bush, W.

Mar. 23, 1866. Nation, W. J., 30, King square, Goswell road, E.C.

Feb. 22, 1878. Needham, S. H., F.R.G.S., F.G.S., 33, Somerfield road, Finsbury park, N.

Mar. 24, 1876. Nelson, E. M., Cleve house, West End lane, West Hampstead, N.W.

Mar. 24, 1871. Nelson, James, 3, Oakden street, Kennington road, S.E.

Nov. 25, 1881. Nevins, R. T. G., 80, Tufnell park road, N.

May 23, 1879. Newcombe, Prout, Northcote, East Croydon.

Nov. 23, 1877. Newth, A. H., M.D., Science Club, 4, Savile row, W.

Jan. 26, 1872. NEWTON, E. T., F.G.S. (*Vice President*), Geological Museum, Jermyn street, S.W.

Feb. 27, 1880. Niven, George, 41, Albert road, Finsbury park, N.

Date of Election.	
May 22, 1874.	Nixon, P. C., Oporto, Portugal.
Mar. 25, 1881.	Norman, Edwin, 178, City road, E.C.
Aug. 26, 1881.	Northey, M. D., 4, Lower Brighton terrace, Surbiton.
Jan. 24, 1879.	Offord, J. M., 6, Boundary road, St. John's Wood, N.W.
Dec. 22, 1876.	Ogilvy, C. P., F.L.S., Sizewell house, Leiston, near Saxmundham, Suffolk.
May 24, 1878.	O'Hara, Lt.-Col. Richard, F.R.M.S. (late Royal Artillery), West Lodge, Galway.
June 23, 1882.	Ollard, John Alex., F.R.M.S., Y^{e} Hermitage, Forty hill, Enfield.
July 28, 1882.	Ondaatje, Dr. W. C., F.R.M.S., Ceylon.
Dec. 27, 1867.	Oxley, Frederick, F.R.M.S., 8, Crosby square, Bishopsgate street, E.C.
July 25, 1879.	Palmer, G. H., 95, Cornwall gardens, S.W.
May 22, 1874.	Palmer, Thomas, B.Sc., F.R.M.S., Holme Lee, Lower Camden, Chislehurst, Kent.
Oct. 27, 1871.	Parsons, F. A., 90, Leadenhall street, E.C.
Dec. 28, 1877.	Partridge, Thos., M.D., Stroud, Gloucestershire.
April 23, 1875.	Peal, C. N., F.R.M.S., Fernhurst, Mattock lane, Ealing, W.
Feb. 23, 1883.	Pearce, Fredk. Ernest, 14, Bloomsbury street, W.C.
May 24, 1867.	Pearce, George, Brabourne Haigh, Highwood hill, Mill hill, W.
May 24, 1867.	Pearson, John, 212, Edgeware road, W.
July 22, 1881.	Perigal, Henry, F.R.A.S., F.R.M.S., 9, North crescent, Bedford square, W.C.
Oct. 27, 1865.	Pickard, J. F., 195, Great Portland street, W.
May 23, 1879.	Pilcher, W. J., F.R.C.S., &c., Boston, Lincolnshire.
June 24, 1881.	Pilley, J. J., 8, Ellesmere road north, Bow, E., and The Old College, Dulwich.
Jan. 22, 1869.	Pillischer, Moritz, F.R.M.S., 88, New Bond street, W.
Nov. 24, 1871.	Pitts, Frederick, Harvard house, St. John's hill, Clapham, S.W.

Date of Election.	
Sept. 27, 1878.	Plomer, G. D., F.R.M.S., 48, Springfield road, St. John's Wood, N.W.
Sept. 28, 1877.	Pocklington, Henry, F.R.M.S., 20, Park road. Leeds.
Nov. 23, 1866.	Potter, George, F.R.M.S., 42, Grove road, Holloway, N.
Jan. 25, 1878.	Potts, R. A., 26, South Audley street, W.
June 24, 1881.	Potts, William, Hillside avenue, Beckenham, Kent.
June 22, 1866.	Powe, I., 71, George street, Richmond, Surrey.
Aug. 25, 1882.	Powell, George, 86, Avondale square, S.E.
May 25, 1866.	Powell, Hugh, F.R.M.S., 170, Euston road, N.W.
April 25, 1879.	Powell, H. P., The Butts, Brentford.
May 26, 1876.	Powell, J. T., 32, Dunlace road, Lower Clapton, E.
July 7, 1865.	Powell, Thomas, F.R.M.S., 18, Doughty street, Mecklenburg square, W.C.
Jan. 22, 1875.	Power, H. D'Arcy, F.L.S.
April 25, 1879.	Preedy, W. H., 41, Oseney crescent, Camden road, N.W.
June 27, 1873.	Priest, B. W., 22, Parliament street, S.W.
May 23, 1879.	Pritchard, J. D., Crymlyn Burrows, near Swansea.
July 26, 1867.	Pritchett, Francis, Clifford house, South Norwood park, S.E.
Feb. 25, 1881.	Probyn, Clifford, 55, Grosvenor street, W.
April 23, 1868.	Quekett, A. J. S., 51, Warwick road, Maida hill, W.
April 23, 1868.	Quekett, A. E, 51, Warwick road, Maida hill, W.
April 23, 1868.	Quekett, Rev. Wm., The Rectory, Warrington.
Feb. 23, 1866.	Quick, G. E., 74, Long lane, Bermondsey, S.E.
Oct. 26, 1866.	Rabbits, W. T., Irongates, Dacres road, Forest hill, S.E.
Oct. 22, 1880.	Radcliffe, William, 43, Queen's road, Brownswood park, N.
June 25, 1875.	Radford, W. S., M.D., F.R.M.S., Sidmouth.

Date of Election.	
Oct. 26, 1866.	Ramsden, Hildebrand, M.A. Cant., F.L.S., F.R.M.S., 26, Upper Bedford place, Russell square, W.C.
Aug. 28, 1868.	Rance, T. G., Elmside, Bickley, Kent.
June 24, 1881.	Ransom, F., Fairfield, Hitchin.
July 23, 1880.	Read, Rev. William, M.A., F.R.A.S., F.R.M.S., &c., Worthing, Sussex.
Dec. 27, 1878.	Reed, J. M., Sidmouth house, South park, Ilford, E.
June 22, 1877.	Reed, J. W., F.R.G.S., F.R.M.S., 17, Colebrooke row, Islington, N.
June 27, 1873.	Reeve, Frederick, 113, Clapham road, S.W.
July 7, 1865.	Reeves, W. W., F.R.M.S., 36, Ashburnham grove, Greenwich, S.E.
May 22, 1874.	Reid, W. W., Corra Lynn, Selhurst park, South Norwood, S.E.
Oct. 28, 1881.	Reynolds, W. P., 74, King William street, E.C.
May 23, 1879.	Rideout, William, F.R.M.S. (*Hon. Sec. Bolton Microscopical Club*), Hulliwell, Bolton.
June 25, 1869.	Roberts, J. H., F.R.C.S., 82, Finchley road, St. John's wood.
April 26, 1872.	Roberts, S. H., F.R.M.S.
May 22, 1868.	Rogers, John, F.R.M.S., 4, Tennyson street, Nottingham.
Oct. 26, 1866.	Rogers, Thomas, F.L.S., F.R.M.S., Selmeston house, Thurlow park road, West Dulwich.
May 22, 1868.	Roper, Freeman C. S., F.L.S., F.G.S., F.R.M.S., Palgrave house, Eastbourne, Sussex.
June 23, 1876.	Roper, H. J., F.R.M.S., 5, Lausanne road, Peckham, S.E.
Oct. 27, 1876.	Roper, Robert, 29, Hampton road, Upton, Essex.
Jan. 26, 1883.	Rousselet, Charles, 42, Welbeck street, W.
July 24, 1868.	Rowe, James, jun., M.R.C.V.S., 65, High street, Marylebone, W.
Oct. 26, 1866.	Rowlett, John, 92, Inville road, Walworth, S.E.
Aug. 26, 1881.	Roy, L., B.A., 1, Lady Margaret's road, Kentish town, N.W.
Sept. 24, 1880.	Rudkin, F. D., 80, Moray road, Tollington park, N.

Date of Election.

Oct. 27, 1865. Russell, James, 10, High street, Shoreditch, E.
May 22, 1868. Russell, T. D., Coningsby villas, Rosendale road, West Dulwich, S.E.
Feb. 22, 1867. Rutter, H. L., 24, Crownhurst road, Angel road, Brixton, S.W.

Nov. 22, 1878. Sabel, E. E., 6, Grove road, Clapham park, S.W.
May 23, 1873. Salkeld, Lt.-Col. J. C., F.R.M.S., 29, St. James's street, S.W.
Dec. 27, 1878. Salmon, C. W., 7, Manor park villas, Manor road, Stoke Newington, N.
Dec. 17, 1869. Salmon, John, 24, Seymour street, Euston square, N.W.
Dec. 28, 1877. Sands, Charles, 5, Woburn place, Russell square, W.C.
May 28, 1875. Saul, G. W.
June 27, 1879. Sawyer, G. D., F.R.M.S., 55, Buckingham place, Brighton.
Feb. 27, 1880. Schulze, Adolf, 1, St. James's street, Hillhead, Glasgow, N.B.
Feb. 26, 1875. Schofield, W. J., M.R.C.S., F.L.S., 13, South hill park gardens, Hampstead, N.W.
Mar. 24, 1882. Selby, Henry, 71, Alderney street, Pimlico, S.W.
May 24, 1872. Sequeira, H. L., M.R.C.S., 1, Jewry street, Aldgate, E.C.
July 27, 1868. Sewell, Richard, Ashmare house, Keston, Kent.
May 25, 1883. Sharer, W. R., 208, East India Dock road, Poplar, E.
July 23, 1880. Shaw, H. V., Fir Croft, Keymer, Hurstpierpoint, Sussex.
Oct. 22, 1869. Shaw, W. F., Mosshall grove, Finchley, N.
May 26, 1876. Shepheard, Thomas, F.R.M.S., Kingsley lodge, Chester.
May 26, 1871. Sigsworth, J. C., F.R.M.S., 18, Chaucer road, Herne hill, S.E.
June 27, 1873. Simmonds, J. E., Royal Exotic Nursery, King's road, Chelsea, S.W.
Aug. 23, 1867. Simmons, J. J., L.D.S., 18, Burton crescent, Euston road, N.W.

Date of Election.

Oct. 28, 1881. Simons, W. V., 19, Manley terrace, Kennington park, S.E.

May 26, 1876. Simpson Edward, 24, Grummant road, Peckham road, S.E.

Feb. 23, 1883. Simpson, Isaac, 1, Junction road, Upper Holloway, N.

Nov. 23, 1877. Simpson, Thomas, Fennymere, Castlebar, Ealing, W.

Mar. 27, 1868. Simson, Thomas, St. Peter's alley, Cornhill, E.C.

May 28, 1869. Sketchley, H. G., care of S. A. Sketchley, Esq., War Office, Pall Mall, S.W.

Dec. 28, 1866. Slade, J., Albion road, Bexley heath, Kent.

Oct. 23, 1868. Smart, William, 27, Aldgate, E.

May 25, 1866. Smith Alpheus (*Hon. Librarian*), 39, Choumert road, Rye lane, Peckham, S.E.

April 23, 1880. Smith, A. S., Silvermere, Cobham, Surrey.

Oct. 26, 1877. Smith, B. E., Normal School of Science, South Kensington Museum, S.W.

July 25, 1879. Smith, C. V., 5, Parade, Carmarthen.

Feb. 25, 1876. Smith, Edward, F.S.S., St. Mildred's house, Poultry, E.C.

Mar. 25, 1870. Smith, F. L., 3, Grecian cottages, Crown hill, Norwood, S.E.

June 27, 1873. Smith, G. J., F.R.M.S., 73, Farringdon street, E.C.

June 26, 1868. Smith, James, F.L.S., F.R.M.S., 12, Buckingham road, De Beuvoir Town, N.

Dec. 23, 1870. Smith, J. A., Eastwell, Westgate road, Beckenham, Kent.

Oct. 26, 1877. Smith, Samuel, Maldon house, 17, Sydenham park, S.E.

Mar. 24. 1882. Smith, W. Dalton, 2, Craigs court, Charing Cross, S.W.

Aug. 23, 1872. Smith, W. S., 30, Loraine road, Holloway, N.

May 26, 1882. Snell, H. Saxon, junr., 86, Belsize road, St. John's Wood, N.W.

April 24, 1868. Snellgrove, W., 58, Cranfield road, Wickham park, S.E.

Aug. 22, 1879. Soames, Rev. H. A., B.A.

Sept. 22, 1865. Southwell, C., 44, Princes street, Soho, W.

Date of Election.

May 26, 1876. Southwell, C. W., 35, Douglas road, Cannonbury, N.

May 22, 1874. Spencer, James, F.R.M.S., 50, South street, Greenwich, S.E.

June 26, 1868. Spencer, John, Brooks' Bank, 81, Lombard street, E.C.

Nov. 22, 1872. Spencer, Thomas, F.C.S., F.R.M.S., 32, Euston square, N.W.

Mar. 24, 1866. Starling, Benjamin, 9, Gray's inn square, W.C.

Aug. 23, 1878. Steel, J. H., M.R.C.V.S., F.Z.S., The Royal Veterinary college, Camden town, N.W.

Aug 24, 1866. Steward, J. H., F.R.M.S., 406, Strand, W.C.

June 22, 1877. STEWART, CHARLES, M.R.C.S., F.L.S. (*Sec. R.M.S.*), &c. (*Vice-President*), St. Thomas' hospital and 42, Sinclair road, Kensington, W.

April 23, 1880. Stewart, Frederick.

Sept. 22, 1876. Stiles, M. H.

May 23, 1879. Stocken, James, 21, Endsleigh gardens, N.W.

Jan. 23, 1880. Stœssiger, F. A., 70, Windsor road, Holloway, N.

June 24, 1881. Stokes, A. W., F.C.S., Laboratory, Vestry hall, Paddington, W.

July 25, 1879. Stone, E. M., Hill side, West hill, Sydenham, S.E.

May 23, 1879. Stubbins, John, F.G.S., F.R.M.S., Chester cottage, Old lane, Halifax.

May 23, 1879. Sturt, Clifton.

Sept. 23, 1881. Sturt, Gerald, 27, Gordon square, W.C.

July 7, 1865. Suffolk, W. T., F.R.M.S., Stettin lodge, St. Faith's road, Lower Norwood, S.E.

June 27, 1873. Suter, E. D., Parkfield, St. Andrew's park, Hastings.

June 24, 1870. Swain, Ernest, 17, Tadmor street, Shepherd's Bush, W.

Nov. 22, 1867. Swainston, J. T., 3, St. Mark's square, Regent's park, N.W.

Nov. 24, 1866. Swansborough, E., 20, John street, Bedford row, W.C.

Dec. 17, 1875. Swift, M. J., 81, Tottenham court road, W.C.

Date of Election.

Jan. 23, 1880.	Symons, W. H., F.C.S., F.R.M.S., 2, Queen's terrace, St. John's wood, N.W.
July 27, 1877.	Tanqueray, A. C., Reid's Brewery, Theobald's road, E.C.
Nov. 28, 1879.	Tasker, J. G., 18, Junction road, Upper Holloway, N.
Aug. 22, 1879.	Tate, J. W., 6, Clarendon terrace, Brentford road, Turnham green, W.
May 22, 1868.	Tatem, J. G., Russell street, Reading.
Feb. 25, 1881.	Taylor, Thomas, M.R.C.S., L.A.C., Bocking, near Braintree, Essex.
Aug. 23, 1878.	Teasdale, Washington, F.R.M.S., Rosehurst, Headingley, Leeds.
Dec. 22, 1865.	Terry, John, 4, Coventry park, Streatham, S.W.
Aug. 23, 1872.	Terry, Thomas, 5, Austin friars, E.C.
May 23, 1879.	Thompson, I. C., F.R.M.S., Woodstock, Waverley road, Liverpool.
May 28, 1875.	Thomson, J. R., 15, Highbury place, Islington, N.
Feb. 24, 1871.	Thornthwaite, W. H., 416, Strand, W.C.
April 27, 1877.	Thorpe, George, 20, Eastcheap, E.C.
Oct. 27, 1882.	Thurston, Edgar, L.R.C.P., L.S.A., A.K.C., 53, Henry street, Regent's park, N.W.
Jan. 22, 1875.	Tinney, W. A., 7, The Terrace, Camberwell, S.E.
Nov. 27, 1867.	Tomkins, S. L., Apsley, East Grinstead.
June 23, 1871.	Topping, Amos, 28, Charlotte street, Caledonian road, N.
June 23, 1882.	Trinder, Stephen, 90, Morton road, Islington, N.
July 24, 1868.	Tulk, John A., M.D., F.R.M.S., Burton lodge, Staines road, Twickenham.
July 26, 1867.	Turnbull, J., Laurel house, North hill, Highgate, N.
Aug. 24, 1877.	Turner, E. B., 1, Clifton villas, Amberley road, Lea bridge road, N.E.
June 25, 1869.	Turner, R. D., Roughway, near Tonbridge.
June 25, 1875.	Turner, Sydney, A.R.I.B.A.
Feb. 25, 1881.	Tyler, Charles, F.L.S., F.G.S., F.R.M.S., 317, Holloway road, N.

Date of Election.	
May 25, 1877.	Veasey, R. G., Ashchurch lodge, Ashchurch road, Shepherd's bush, W.
Feb. 28, 1879.	Venables, W., 253, Camden road, N.W.
Feb. 27, 1880.	Vereker, The Hon. J. G. P., 1, Portman square, W.
Feb. 25, 1881.	Vereker-Bindon, W. J., M.D., F.R.C.S.E.
May 23, 1879.	Vezey, J. J., F.R.M.S., 12, Sandbourne road, Brockley rise, S.E.
Mar. 24, 1882.	Vicars, John, 7, Hartington road, Liverpool.
June 25, 1880.	Waddington, H. J., 39, Gower street, W.C.
Feb. 27, 1874.	Walker, J. C., Highfield avenue road, Crouch end, N.
July 25, 1873.	Walker, J. S., Warwick road, Upper Clapton, E.
June 26, 1868.	Walker, J. W., Melrose villa, Watford.
May 22, 1868.	Waller, J. G., 68, Bolsover street, Portland road, W.
Aug. 26. 1870.	Warburton, Samuel, Merton villa, New road, Lower Tooting, S.W.
Nov. 22, 1867.	Ward, F. H., M.R.C.S., F.R.M.S., Springfield house, near Tooting, S.W.
Feb. 25, 1881.	Ward, J. D., Northwood lodge, Cowes, Isle of Wight.
June 28, 1878.	Ward, R. J., Silver street, Lincoln.
May 25, 1866.	Warrington, H. R., 7, Royal Exchange, Cornhill, E.C.
Oct. 27, 1865.	Watkins, C. A., Rosemont, Greenhill road, Hampstead, N.W.
Oct. 25, 1872.	Watkins, J., L.C.P., 24, Lime grove, Lewisham, S.E.
Aug. 23, 1878.	Watson, G. F., 313, High Holborn, W.C.
Nov. 28, 1879.	Watson, R. W., 22, Highbury new park, N.
Sept. 28, 1877.	Watson, T. P., F.R.M.S., 313, High Holborn, W.C.
Dec. 28, 1877.	Watson, T. W., 4, Pall Mall, S.W.
May 23, 1879.	Watts, The Rev. G. E., M.A., F.R.M.S., Kensworth vicarage, Dunstable, Herts.
Dec. 28, 1866.	Way, T. E., Argyll road, Ealing, W.
Oct. 26, 1877.	Weatherley, Capt. H. C. S., 64, Cheapside, E.C.
July 24, 1874.	Webb, C. E., Wildwood lodge, North end, Hampstead, N.W.

Date of Election.	
April 25, 1879.	Webster, H. W., M.D., St. George's Infirmary, Fulham road, S.W.
May 24, 1867.	Weeks, A. W. G., 36, Gunter grove, West Brompton, S.W.
Sept. 27, 1878.	West, R. G., 39, Lombard street, E.C.
May 26, 1882.	Western, George E., 28, Aynhoe road, West Kensington park, W.
Feb. 25, 1876.	Wheeler, George, 27, Theberton street, N.
May 23, 1879.	Wheldon, John, F.R.M.S., 58, Great Queen street, Lincoln's Inn Fields, W.C.
Sept. 23, 1881.	Whelpton, E. S., B.A., Cantab., Boyland Oak, Streatham hill, S.W.
May 22, 1868.	WHITE, T. CHARTERS, M R.C.S., L.D.S., F.L.S. F.R.M.S. (*Past President, Vice-President*), 32, Belgrave road, S.W.
July 25, 1873.	White, Walter, Litcham, Norfolk.
Aug. 22, 1879.	Whittell, H. T., M.D., F.R.M.S., Aston villa, near Glenelg, South Australia.
June 25, 1880.	Wickes, W. D., 3, Cottage grove, Bow road, E.
Mar. 25, 1881.	Wildy, Arthur, 48, Albion road, South Hampstead, N.W.
April 23, 1880.	Williams, Arthur, 48, Osnaburg street, Regent's park, N.W.
July 28, 1882.	Williams, Benjamin, 3, Comberton road, Upper Clapton, E.
Mar. 24, 1871.	Williams, George, F.R.M.S., 135, Coningham road, Shepherd's bush, W.
Nov. 23, 1877.	Williams, G. S., 20, Oxford road, Kilburn, N.W.
Aug. 25, 1882.	Williams, S., 263, Lower road, Deptford, S.E.
June 27, 1879.	Willson, James, 2, Oval road, Regent's park, N.W.
Mar. 24, 1876.	Wilson, C. J., 14, Highbury crescent, N.
Feb. 22, 1867.	Wilson, Frank, 110, Long acre, W.C.
Jan. 24, 1879.	Wilson, S. K., F.R.G.S., F.R.MS., M.R.I., 3, Portland terrace, Regent's park, N.W.
April 23, 1880.	Winney, H. J., 1, Shorters court, Throgmorton street, E.C.
Aug. 27, 1869.	Woods, W. Fell, 1, Park hill, Forest hill, S.E.
Jan. 28, 1876.	Woollett, John, 58, Cloudesley road, Islington, N.

Date of Election.	
Oct. 25, 1867.	Worthington, Richard, Champion park, Denmark hill, S.E.
June 27, 1873.	Wrey, G. E. B., Addington house, Addington road, Reading.
Aug. 22, 1879.	Wright, B. M., 54, Guilford street, Russell, square, W.C.
Nov. 26, 1880.	Wright, J. H., jun., Merston house, Ealing, W.
Nov. 25, 1881.	Wyatt, Robert, B.A., 7, Dunford road, N.
May 25, 1877.	Yates, Francis, Rockwood, Surbiton hill.
Jan. 25, 1878.	Yates, Robert, 64, Park street, Southwark, S.E.
Oct. 26, 1866.	Yeats, Christopher, Mortlake, Surrey, S.W.
June 22, 1883.	Young, William Martin, 16, Maclise road, West Kensington park, W.

NOTICE.

Members are requested to give early information to one of the Hon. Secretaries of any change of residence, so as to prevent miscarriage of Journals and Circulars.

RULES.

I.—That the Quekett Microscopical Club hold its Meetings at University College, Gower Street, on the fourth Friday Evening in every month, at Eight o'clock precisely, or at such other time or place as the Committee may appoint.

II.—That the business of the Club be conducted by a Com mittee, consisting of a President, four Vice-Presidents, an Honorary Treasurer, one or more Honorary Secretaries, an Honorary Secretary for Foreign Correspondence, an Honorary Reporter, an Honorary Librarian, an Honorary Curator, and twelve other Members,—six to form a quorum. That the President, Vice-Presidents, Treasurer, Secretaries, Reporter, Librarian, Curator, and the four senior Members of the Committee (by election) retire annually, but be eligible for re-election. That the Committee may appoint a stipendiary Assistant-Secretary, who shall be subject to its direction.

III.—That at the ordinary Meeting in June nominations be made of Candidates to fill the offices of President, Vice-Presidents, Treasurer, Secretaries, Reporter, Librarian, Curator, and vacancies on the Committee. That the President, Vice-Presidents, Treasurer, Secretaries, Reporter, Librarian, and Curator be nominated by the Committee. That the nominations for Members of Committee be made by the Members on resolutions duly moved and seconded, no Member being entitled to propose more than one Candidate. That a list of all nominations made as above be printed upon the ballot paper ; the nominations for vacancies upon the Committee being arranged in such order as shall be determined by lot, as drawn by the President and Secretary. That at the Annual General Meeting in July all the above Officers be elected by ballot from the Candidates named in the lists, but any Member is at liberty to substitute on his ballot-paper any other name or names in lieu of those nominated for the offices of President, Vice-Presidents, Treasurer, Secretaries, Reporter, Librarian, and Curator.

IV.—That in the absence of the President and Vice-Presidents the Members present at any ordinary Meeting of the Club elect a Chairman for that evening.

V.—That every Candidate for Membership be proposed by two or more Members, who shall sign a certificate (see Appendix) in recommendation of him—one of the proposers from personal knowledge. The certificate shall be read from the chair, and the Candidate therein recommended balloted for at the following Meeting. Three black balls to exclude.

VI.—That the Club include not more than twenty Honorary Members, elected by the Members by ballot upon the recommendation of the Committee.

VII.—That the Annual Subscription be Ten Shillings, payable in advance on the 1st of July, but that any Member elected in May or June be exempt from subscription until the following July. That any Member desirous of compounding for his future subscription may do so at any time by payment of the sum of Ten Pounds ; all such sums to be duly invested in such manner as the Committee shall think fit. That no person be entitled to the full privileges of the Club until his subscription shall have been paid ; and that any Member omitting to pay his subscription six months after the same shall have become due (two applications in writing having been made by the Treasurer) shall cease to be a Member of the Club.

VIII.—That the accounts of the Club be audited by two Members, to be appointed at the ordinary Meeting in June.

IX.—That the Annual General Meeting be held on the fourth Friday in July, at which the Report of the Committee on the affairs of the Club, and the Balance Sheet duly signed by the Auditors, shall be read. Printed lists of Members nominated for election as President, Vice-Presidents, Treasurer, Secretaries, Reporter, Librarian, Curator, and Members of the Committee having been distributed, and the Chairman having appointed two or more Members to act as Scrutineers, the Meeting shall then proceed to ballot. If from any cause these elections, or any of them, do not take place at this Meeting, they shall be made at the next ordinary Meeting of the Club.

X.—That at the ordinary Meetings the following business be transacted :—The minutes of the last Meeting shall be read and confirmed ; donations to the Club since the last Meeting announced and exhibited ; ballots for new Members taken ; papers read and discussed ; and certificates for new Members read ; after which the Meeting shall resolve itself into a Conversazione.

XI.—That any Member may introduce a Visitor at any ordinary Meeting, who shall enter his name with that of the Member by whom he is introduced in a book to be kept for the purpose.

XII.—That no alteration be made in these Rules, except at an Annual General Meeting, or a Special General Meeting called for that purpose ; and that notice in writing of any proposed alteration be given to the Committee, and read at the ordinary Meeting at least a month previous to the Annual or Special Meeting at which the subject of such alteration is to be considered.

APPENDIX.

Form of Proposal for Membership.

Quekett Microscopical Club.

Mr.

of

being desirous of becoming a Member of this Club, we beg to recommend him for election.

(*On my personal knowledge.*)

This Certificate was read 18

The Ballot will take place 18

MEETINGS

OF THE

QUEKETT MICROSCOPICAL CLUB, 1883-4,

AT

UNIVERSITY COLLEGE GOWER STREET,

ON THE

Second and Fourth Fridays of every Month.

1883.—Friday,	August	...	...	10 ...	24
	September	...	...	14 ...	28
	October	...	...	12 ...	26
	November	..	...	9 ...	23
	December	...	...	14 ...	28
1884.—Friday	January	...	...	11 ...	25
	February	...	...	8 ...	22
	March ...	...	...	14 ...	28
	April ...	...	...	* ...	25
	May ...	...	...	9 ...	23
	June ...	...	...	13 ...	27
	July ...	...	...	11 ...	25

* April 11th—Good Friday, no Meeting.

The ORDINARY MEETINGS are held on the *fourth* Friday in each month. Business commences at Eight o'clock p.m.

The MEETINGS on the *second* Friday in each month are for Conversation and Exhibition of Objects, from 7 to 9.30 p.m.

The ANNUAL GENERAL MEETING will be held on July 25th, 1884, at Eight o'clock, for Election of Officers and other Business.

EXCURSIONS, 1883.

April 7.	REGENT'S CANAL. To meet at Chalk Farm Station.	
April 21.	HIGHGATE STATION, for CAEN WOOD. To meet at Moorgate Street and King's Cross Stations.	
May 5.	CATERHAM, for GODSTONE. To meet at Cannon Street Station.	
May 19.	BROMLEY, for KESTON. To meet at Holborn Viaduct Station.	
June 2.	DAY EXCURSION, WHITSTABLE. To meet at Holborn Viaduct Station, 10 a.m., or next later Train.	
June 16.	WOKING, returning by Weybridge. To meet at Waterloo, Main Line Station.	
June 30.	EXCURSIONISTS' ANNUAL DINNER. Arrangements will be duly announced.	
July 14.	HAMPTON COURT. To meet at Waterloo, Suburban Station.	
July 28.	WOOD STREET, for WHIP'S CROSS. To meet at Liverpool Street and Fenchurch Street Stations.	
Sept. 8.	SHEPPERTON, for WALTON. To meet at Waterloo, Loop Line Station.	
Sept. 22.	TOTTERIDGE, returning by Mill Hill. To meet at Moorgate Street Station.	
Oct. 6.	SNARESBROOK, returning by George Lane. To meet at Liverpool Street and Fenchurch Street Stations.	
Oct. 20.	HOMERTON, for HACKNEY MARSHES. To meet at Homerton Station.	

The time for departure from Town, unless otherwise specified, will be the First Train after TWO o'clock.

W. G. Cocks,	J. D. Hardy,	Excursion Committee.
E. Dadswell,	F. Oxley,	
F. W. Gay,	W. W. Reeves,	
W. Goodwin,		